SERIES 520 – MODELS 521, 522, 523, AND 524
ANALOG AND DIGITAL SETPOINT CONTROLLERS

AMBER LAMP ON CONTROLLERS
Either glows to indicate Output 1's solid state switching is on,
or
Steady glow if Output 1 is a current output, to indicate power is on to the instrument.

RED LAMP ON LIMITROL
Steady glow indicates selected setpoint is exceeded

WHITE LAMP ON DUAL OUTPUT CONTROLLERS
Glows to indicate Output 2's solid state switching is on

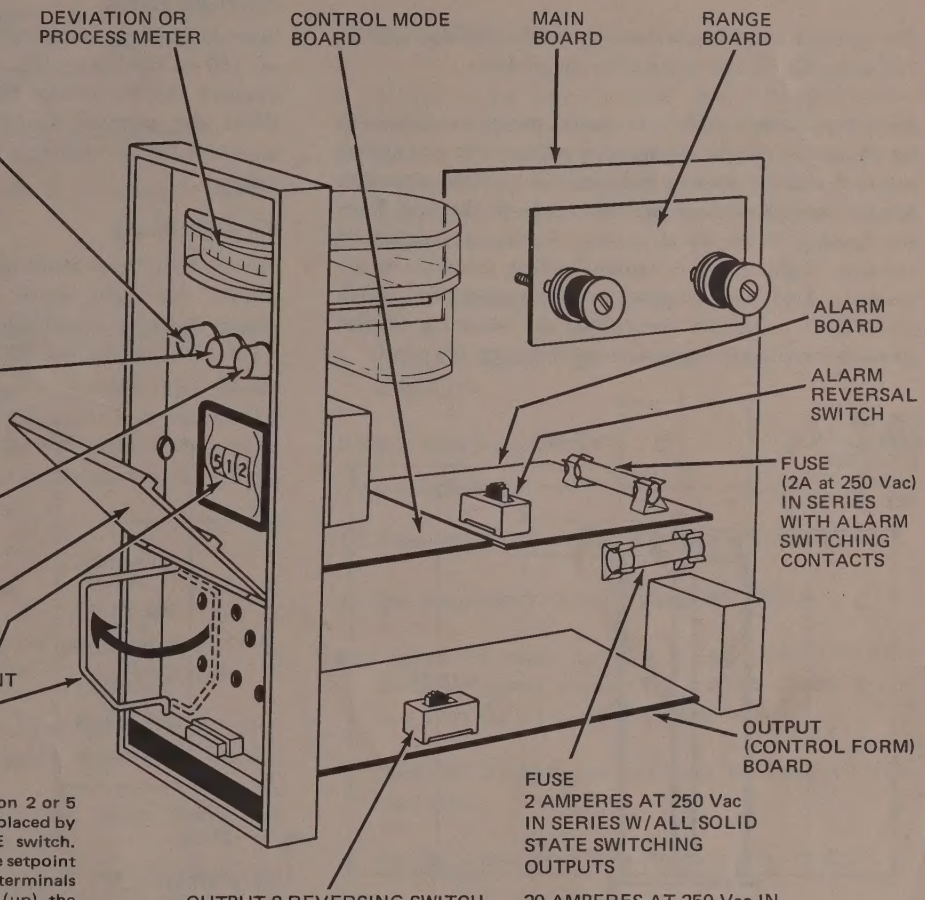
RESET PUSHBUTTON ON LIMITROL
Press to reset Limitrol after excess temperature drops below setpoint

RED ALARM LAMP
Steady glow indicates an alarm

DOOR SWUNG UP TO REVEAL TAMPER PROOF CONTROLS

DIGITAL SETPOINT

HANDLE:--Pull out to remove controller from its housing.


DEVIATION OR PROCESS METER
CONTROL MODE BOARD
MAIN BOARD
RANGE BOARD
ALARM BOARD
ALARM REVERSAL SWITCH
FUSE (2A at 250 Vac) IN SERIES WITH ALARM SWITCHING CONTACTS
OUTPUT (CONTROL FORM) BOARD
FUSE 2 AMPERES AT 250 Vac IN SERIES W/ALL SOLID STATE SWITCHING OUTPUTS
20 AMPERES AT 250 Vac IN SERIES WITH LIMITROL CONTACTS
OUTPUT 2 REVERSING SWITCH FOR ON–OFF OUTPUTS ONLY

NOTE: When either Setpoint Option 2 or 5 is specified the red alarm lamp is replaced by the two position LOCAL-REMOTE switch. In the REMOTE position (down) the setpoint is an external setpoint on rear panel terminals 4 and 5. In the LOCAL position (up) the setpoint is determined by the setpoint control below the switch.

When Setpoint Option 7 is specified the Setpoint is omitted.

When Setpoint Option 8 is specified the Setpoint is replaced by a Trim Control which can be set to adjust the setpoint signal from a Master Controller ± 5% of span.

Figure 2-1. Parts Description

WARNING

FUSE SIZE MUST NOT BE EXCEEDED. COPPER FOIL ON MAIN BOARD WILL BE DESTROYED AT HIGHER CURRENTS.

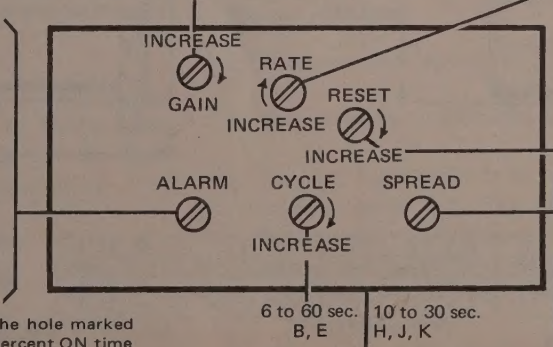
GAIN
Proportional Action Only: 10 to 100 (P.B.: 10 to 1%)
Proportional plus Integral Action: 1 to 100 (P.B.: 100 to 1%)
Derivative (Rate) Action does not affect the gain or P.B.

RATE (DERIVATIVE TIME)
0-3 MINUTES

DEVIATION ALARM
Up to ±25% of span about setpoint

DEVIATION BAND ALARM
Up to 50% maximum bandwidth centered about setpoint

PROCESS ALARM
0-100% of span



MANUAL 0 to 100% output at null

AUTOMATIC .06 to 6 repeats per minute

Determines separation of Output 1 and Output 2 on Dual Output Controllers from -25% to +25% of span from the setpoint selected on the Output 1 setpoint.
Output 2 is switch reversible. Only on models 522E, 523E, 524E, 522F, 523F, 524F, 522G, 523G, and 524G.

COOLING LIMIT ADJUSTMENT (located in the hole marked SPREAD). Continuously adjustable to limit the percent ON time between 5 (CCW) and 100 (CW). This prevents excess cooling. Only on models 522H, 523H, 524H, 522J, 523J, 524J, 522K, 523K, and 524K.

Figure 2-2. Functions of Internal Front Panel Controls

2.1 After Unpacking

Check the contents of the shipping container against the packing slip. If the equipment is damaged in transit, report the extent of the damage to the carrier immediately.

2.2 Mounting

The ambient temperature should be within 40°F to 130°F. The series 520 can be mounted in any position.

After the cutout is made in the panel, proceed as follows to install one instrument. Completely unscrew the two driving screws for the mounting brackets and pull the mounting brackets completely out of their tracks in the case. Place the housing in the panel cut-out. Replace the mounting brackets. Tighten the mounting bracket screws until the brackets hold the housing snugly against the panel. CAUTION: — Do not over-tighten the mounting bracket screws — over-tightening screws could damage the panel.

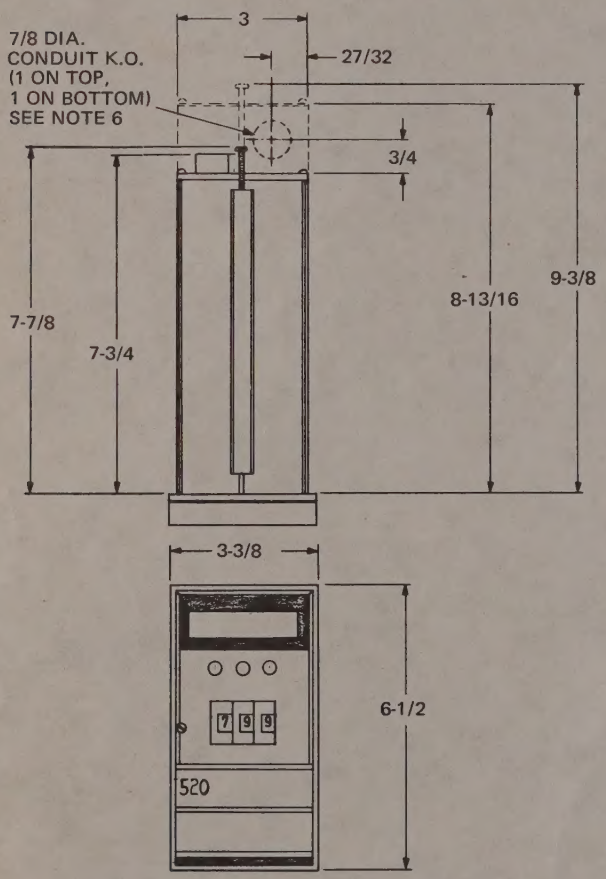
The captive screw on the left side of the panel in the middle is the fastener for the instrument. After the housing is mounted in the panel, push the controller firmly into its slot until the screw touches the threaded hole in back of it. Do not push instrument further but instead turn screw clockwise until instrument is pulled fully into its housing.

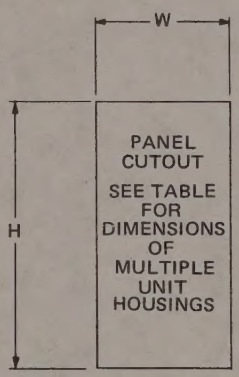
2.3 Power Wiring

Input line voltage must be 120 or 240 Vac, ±10%, at 60 Hz; or, 110 or 220 Vac, ±10%, at 50 Hz; by terminal selection. Connect the line voltage to the terminal marked L2 and either the terminal marked 240V L1 or the terminal marked 120V L1. Connect panel ground to the GROUND terminal.

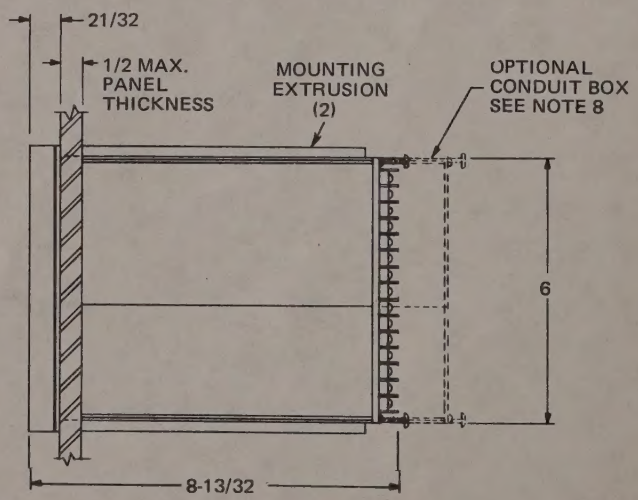
2.4 Input Wiring

The SIGNAL input terminals are marked TC (+ and —) and are for any Input Signal — observe polarity. For RTD sensors there is no polarity to observe. For three wire RTD's, connect the two WHITE wires of the RTD together.





NOTE:
1. ALL DIMENSIONS IN INCHES.
2. TOL. ALL DIM. ± 1/16
3. DIMENSIONS GUARANTEED ONLY IF THIS PRINT IS CERTIFIED.
4. MIN. HORZ. SPACING CENTERS 3-7/16
5. MIN. VERT. SPACING CENTERS 6-9/16
6. APPLETON NO. 92T050 TWO PIECE STEEL CONDUIT CONNECTOR OR EQUIVALENT MUST BE USED FOR CONDUIT CONNECTIONS.
7. FOR MOUNTING IN A 19" RELAY RACK 7" HIGH THE MAX. NO. OF UNITS WILL BE 1 ROW OF 5.
8. CONDUIT BOX FITTED TO CASE AT FACTORY.



NUMBER OF UNITS WIDE W		1	2	3	4	5	6	7	8	9
		3-1/8	6-9/16	10	13-7/16	16-7/8	20-5/16	23-3/4	27-3/16	30-5/8
NUMBER OF UNITS HIGH H	1	6-1/8	1	2	3	4	5	6	7	8	9
	2	12-11/16	2	4	6	8	10	12	14	16	18

TOTAL NUMBER OF UNITS

PANELMOUNT CUT OUT DIMENSIONS SHOWN AT LEFT

Example 1: Single Panelmount cut out is 3-1/8" wide by 6-1/8" high.

Example 2: An array 9 wide by 2 high, cut out is 30-5/8" wide by 12-11/16" high.

Note: — Standard Relay Rack Panel Cut-Outs are made at the factory; and, the housings specified are shipped fastened to the panel.

Figure 2-3. Mounting Dimensions

2.5 Alarms

2.5.1 General

For safety purposes the Models 521L and 521T Limitrols are recommended.

These alarms are not recommended for safety purposes. Alarm boards in the Series 520 are shipped from the factory with the following wiring conditions:

1. Alarm light is on when alarm relay is de-energized.
2. Normally open alarm contact is connected to instrument alarm terminals.

2.5.2 ALARM Potentiometer and Alarm Reversal Switch

Either a Process, a Deviation, or a Deviation Band Alarm may have been specified. The alarm action is determined by the front panel ALARM pot and by a slideswitch located on the Alarm Board. Figure 2-1 shows the location of the switch.

Set the switch as follows.

Process Alarm: pull out to alarm* on decreasing signal, push in to alarm* on increasing signal.

Deviation Alarm: pull out to alarm* on decreasing signal, push in to alarm* on increasing signal.

Deviation Band Alarm: push in to alarm* inside the bandwidth,
pull out to alarm* outside the bandwidth,

*"to alarm" means that terminals 6 and 7 open.

Next, set the ALARM potentiometer.

The Process Alarm can be set to trip anywhere within the span of the instrument by means of the 20-turn ALARM potentiometer. Turn the ALARM pot clockwise to increase the alarm trip point.

The Deviation Alarm can be set to trip up to ±25% of span from setpoint by means of the single turn ALARM potentiometer. With the ALARM pot turned fully CCW the alarm will trip at a deviation of 25% of span below setpoint.

With the ALARM pot fully CW the alarm will trip at a deviation of 25% of span above the setpoint.

The Deviation Band Alarm can be set to trip up to plus and minus 25% of span (total of 50% of span) about setpoint. Turn the single turn ALARM pot clockwise for a wider deviation band.

2.5.3 Setting a Deviation Alarm Trip Point

2.5.3.1 With Millivolt Source Input

Proceed as follows:

1. Disconnect any input or output.
2. Turn power on to the Series 520.
3. Connect a d-c millivolt source (B-C Portable Potentiometer output) to the SIGNAL input terminals. Increase the millivolt input signal until it is above (below for a low deviation alarm) midscale and the difference between the signal and midscale is the desired deviation.
4. Adjust the setpoint to midscale.
5. Turn the ALARM potentiometer until the red alarm lamp lights.

2.5.3.2 With Process Input

Proceed as follows.

1. Allow the process to stabilize at the desired setpoint.
2. Quickly perform steps 3, 4 and 5 that follow.
3. Adjust the setpoint until it is below (above for a low deviation alarm) the desired setpoint mentioned in step 1, by the amount of the alarm deviation.
4. Turn the ALARM potentiometer until the red alarm lamp lights.
5. Quickly return setpoint to the value it had in step 1.

2.5.4 Setting A Deviation Band Alarm

With the Deviation Band Alarm option, when the ALARM potentiometer is fully CW, the bandwidth is 50% of span. When fully CCW, the bandwidth is about 2% of span.

2.5.4.1 With Millivolt Source Input

Proceed as follows.

1. Disconnect any input or output.
2. Turn power on to the Series 520.
3. Connect a d-c millivolt source (B-C Portable Potentiometer output) to the SIGNAL input terminals. Increase the millivolt input signal until it is above (or below) midscale and the difference between the signal and midscale is half the desired bandwidth.
4. Adjust the setpoint to midscale.
5. Turn ALARM potentiometer until red lamp lights.

2.5.4.2 With Process Input

Proceed as follows.

1. Allow the process to stabilize at the desired setpoint.
2. Quickly perform steps 3, 4, and 5 that follow.
3. Adjust the setpoint until it is above (or below) the desired setpoint mentioned in step 1, by the amount of half the bandwidth.
4. Turn the ALARM potentiometer until the red alarm lamp lights.
5. Quickly return setpoint to the value it had in step 1.

2.5.5 Setting A Process Alarm Trip Point

Proceed as follows.

1. Disconnect any input or output.
2. Turn power on to the Series 520.
3. Connect a d-c millivolt source to the SIGNAL input terminals. Adjust the millivolt input signal to the equivalent of the desired alarm temperature.
4. Turn the ALARM potentiometer until the red alarm lamp lights.

2.5.6 Re-connecting the Red Alarm Lamp to Indicate A Safe Condition

Do not make this wiring change for a safety related application. This wiring condition is suitable for such purposes as the following: Indicating that temperature is normal, furnace or extruder is ready to operate, extruder barrel temperature is at required temperature, zone temperature on furnace or extruder is at required temperature.

To make this wiring change refer to Figure 2-4 and proceed as follows. A black lead from the red alarm lamp is connected to terminal D on the Alarm Board. Disconnect the black lead from terminal D and connect it to the adjacent terminal E.

2.5.7 Re-connecting the Normally Open Alarm to Normally Closed

Do not make this wiring change for a safety related application. This wiring condition is suitable for such purposes as the following: programming and sequencing.

To make this wiring change refer to Figure 2-4 and proceed as follows. A gray wire from the printed circuit board connector number 11 is connected to terminal B. Disconnect the gray wire from terminal B and connect it to terminal A.

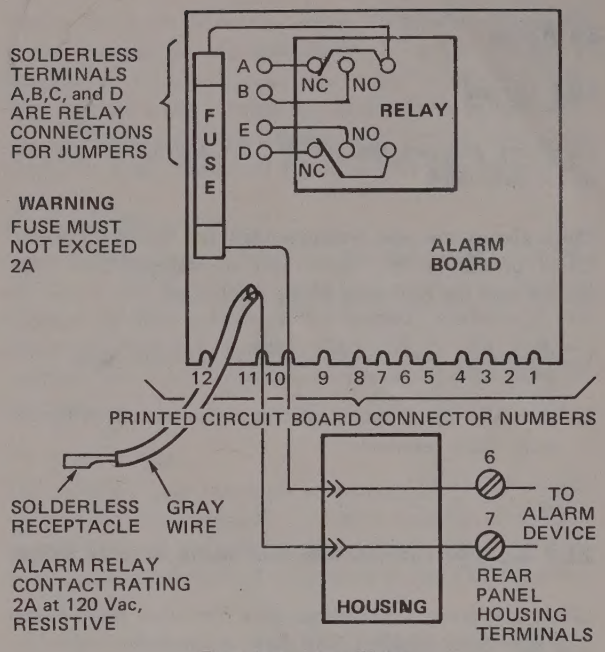


Figure 2-4. Alarm Wiring

2.6 Field Changing The Model 521A To Reverse The ON-OFF Output

——IMPORTANT——
INSTRUMENT MUST HAVE BEEN ORDERED WITH DOWNSCALE TCB (THERMOCOUPLE BREAK PROTECTION) IN ORDER TO MAKE THIS CHANGE.

The Model 521A is shipped with pin A connected to pin B by means of a jumper; and, with pin C connected to pin D by means of a jumper.

To reverse the ON-OFF output, make the jumper connections shown in Figure 2-5; that is, connect pin C to pin B, and connect pin A to pin D.

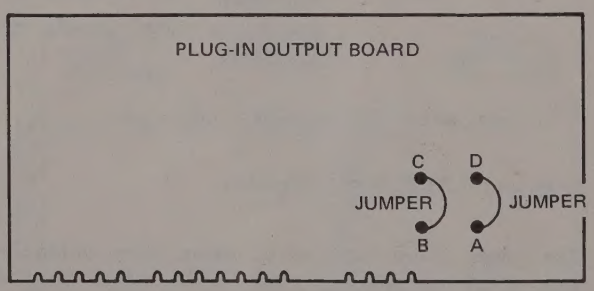


Figure 2-5. Jumpers

2.7 Field Changing the Output of the Models 521L and 521T from High Limit to Low Limit

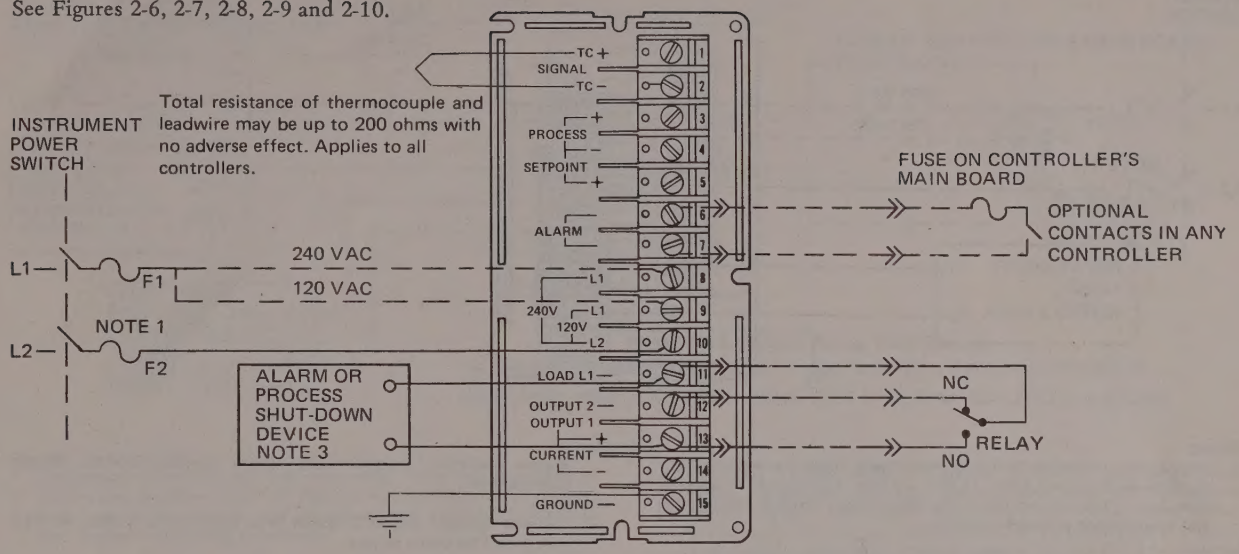
——IMPORTANT——
INSTRUMENT MUST HAVE BEEN ORDERED WITH DOWNSCALE TCB (THERMOCOUPLE BREAK PROTECTION) IN ORDER TO MAKE THIS CHANGE.

The Model 521L is shipped with pin A connected to pin B by means of a jumper; and, with pin C connected to pin D by means of a jumper. This is an "upscale" Limitrol.

To change to a "downscale" Limitrol make the jumper connections shown in Figure 2-5; that is, connect pin C to pin B, and connect pin A to pin D.

2.8 Output Wiring

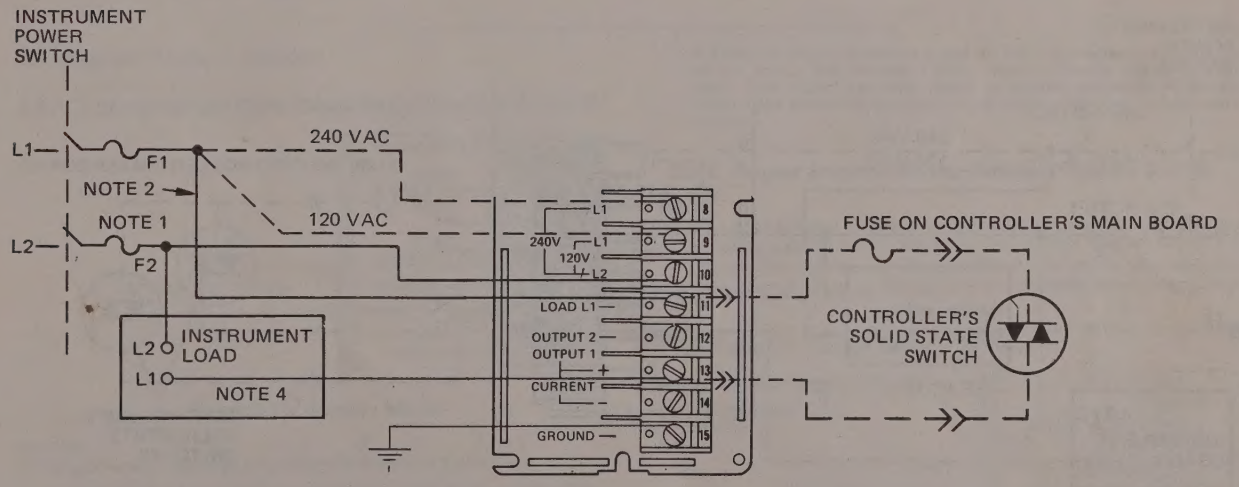
See Figures 2-6, 2-7, 2-8, 2-9 and 2-10.



Notes:

1. Instrument power switch and instrument fuses are included for illustrative purposes only. If the L2 line is a neutral or ground line, fuse F2 is not normally recommended. Consult local codes and appropriate wiring standards.
2. Limitrol Relay Contact Ratings: 5A at 120 or 240 Vac.
3. Power connections are made at the discretion of the installer.

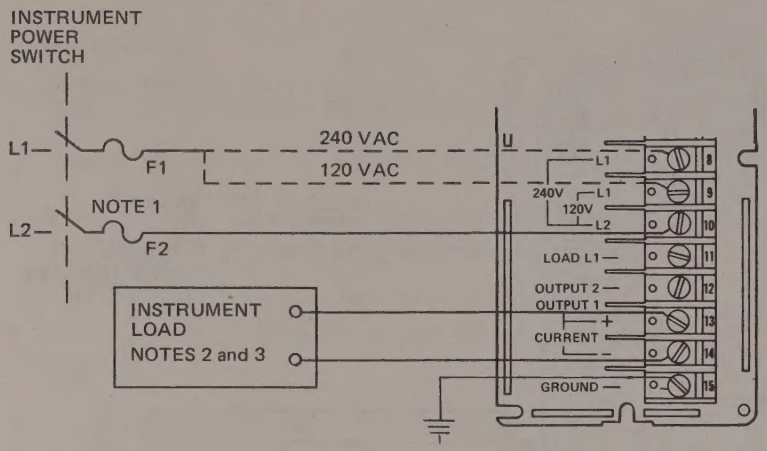
Figure 2-6. Output Wiring, Limitrol (521L and 521T)



Notes:

1. Instrument power switch and instrument fuses are included for illustrative purposes only. If the L2 line is a neutral or ground line, fuse F2 is not normally recommended. Consult local codes and appropriate wiring standards.
2. Instrument load power, LOAD L1, may be obtained from a separate power source in phase with the instrument power supply. Instrument signal light will not operate unless instrument L2 and instrument load L2 are connected as shown. Instrument signal light will not operate if LOAD L1 is powered by a separate source of less than 100 Vac rms.
3. Instrument load may be either a contactor coil, a Barber-Colman SOLID STATE CONTACTOR, or heater.
4. Rating of Solid State Switching Output: (both ON-OFF and Time-Proportioning): 1A continuous, 10A inrush, 30mA minimum. Any voltage from 24 Vac to 240 Vac can be switched but the voltage switched must be the same phase and have the same common line as the instrument power supply.

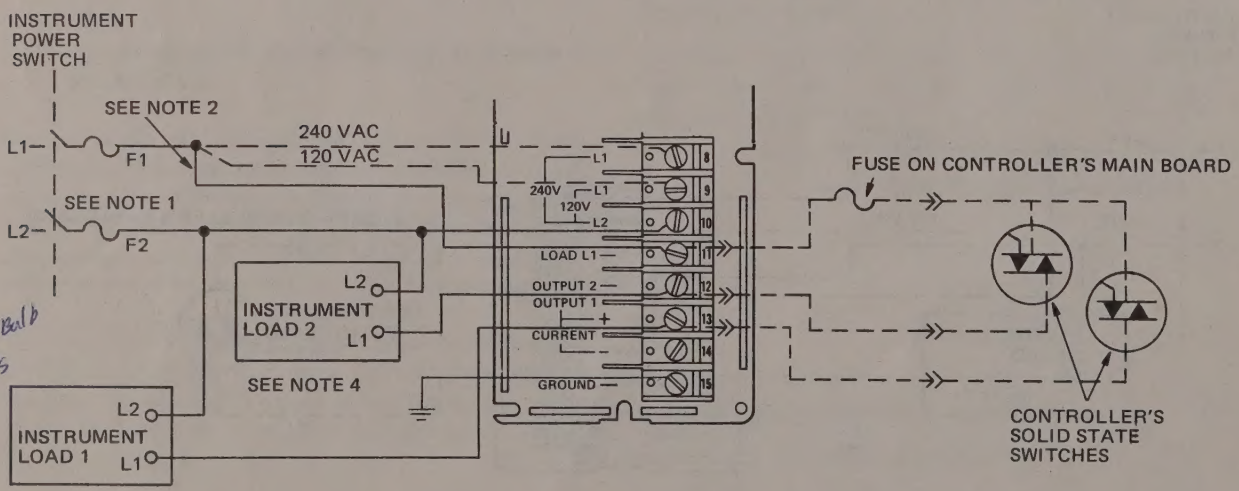
Figure 2-7. Output Wiring, Single Solid State Switching Output (521A, 522B, 523B and 524B)



Notes:

1. Instrument power switch and instrument fuses are included for illustrative purposes only. If the L2 line is a neutral or ground line, fuse F2 is not normally recommended. Consult local codes and appropriate wiring standards.
2. The constant current outputs of these controllers are short circuit proof. Either plus or minus may be grounded or remain floating.
3. Either the 2-12 mA or 4-20 mA output will drive the Model 656 Current-to-Position Converter for positioning a Barber-Colman Motor Operator or the Model PO2R Current-to-Pneumatic Transducer. Either current output will drive Barber-Colman Power Controllers.
4. Current Output: either 2-12mA into 1.5k ohms or less; or 4-20 mA into 750 ohms or less.

Figure 2-8. Output Wiring, Single Current Output (522C, 523C, 524C, 522D, 523D, 524D, 522P, 523P, 524P, 522Q, 523Q and 524Q)



Notes:

1. Instrument power switch and instrument fuses are included for illustrative purposes only. If the L2 line is a neutral or ground line, fuse F2 is not normally recommended. Consult local codes and appropriate wiring standards.
2. Instrument load power, LOAD L1, may be obtained from a separate power source in phase with the instrument power supply. Instrument signal light will not operate unless instrument L2 and instrument load L2 are connected as shown. Instrument signal light will not operate if LOAD L1 is powered by a separate source of less than 100 Vac rms.
3. Instrument load may be either a contactor coil, a Barber-Colman SOLID STATE CONTACTOR, or heater.
4. Rating of Solid State Switching Output: (both ON-OFF and Time-Proportioning): 1A continuous, 20A inrush, 30mA minimum. Any voltage from 24 Vac to 240 Vac can be switched but the voltage switched must be the same phase and have the same common line as the instrument power supply.

Figure 2-9. Output Wiring, Dual Solid State Switching Outputs (522E, 523E, 524E, 522H, 523H and 524H)

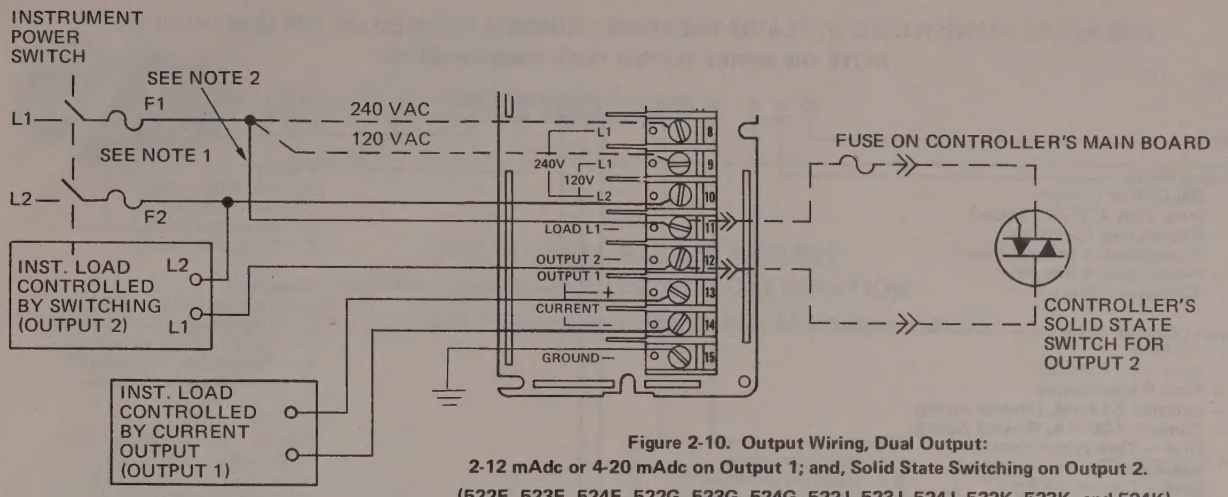


Figure 2-10. Output Wiring, Dual Output:
2-12 mAdc or 4-20 mAdc on Output 1; and, Solid State Switching on Output 2.
(522F, 523F, 524F, 522G, 523G, 524G, 522J, 523J, 524J, 522K, 523K, and 524K)

Notes:

1. Instrument power switch and instrument fuses are included for illustrative purposes only. If the L2 line is a neutral or ground line, fuse F2 is not normally recommended. Consult local codes and appropriate wiring standards.

2. OUTPUT 1: The constant current outputs of these controllers are short circuit proof. Either plus or minus may be grounded or remain floating.

   Either the 2-12 mA or 4-20 mA output will drive the Model 656 Current-to-Position Converter for positioning a Barber-Colman Motor Operator or the Model P02R Current-to-Pneumatic Transducer.

   Either current output will drive Barber-Colman Power Controllers.

   Current Output: either 2-12mA into 1.5k ohms or less; or 4-20mA into 750 ohms or less.

3. OUTPUT 2: Instrument load power, LOAD L1, may be obtained from a separate power source in phase with the instrument power supply. Instrument signal light will not operate unless instrument L2 and instrument load L2 are connected as shown. Instrument signal light will not operate if LOAD L1 is powered by a separate source of less than 100 Vac rms.

   Instrument load may be either a contactor coil, a Barber-Colman SOLID STATE CONTACTOR, or heater.

   Rating of Solid State Switching Output: (both ON-OFF and Time-Proportioning): 1A continuous, 20A inrush, 30mA minimum. Any voltage from 24 Vac to 240 Vac can be switched but the voltage switched must be the same phase and have the same common line as the instrument power supply.

2.9 Setpoint Wiring — Isolated

2.9.1 Input Setpoint Wiring (Setpoint Options 2, 5, 7, and 8)

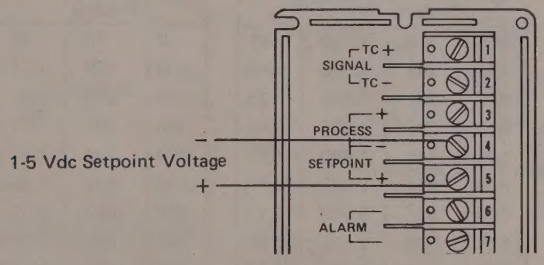


Figure 2-11. Setpoint Wiring

NOTES

1. Setpoint with Remote-Local Switch (Options 2 and 5).

   Source should be free of transients and have an impedance less than 200 ohms. For operation of more than one controller from the same external source, a source resistance under 50 ohms is recommended. Typical input impedance of 1 meg ohm.

   A REMOTE–LOCAL switch on the front panel allows the setpoint source to be either the front panel setpoint or the remote setpoint. For start-up or servicing the instrument may be switched to local setpoint operation. After start-up or servicing, control is returned to the remote setpoint.

2. No setpoint, requires remote setpoint voltage (Option 7)

   Source should be free of transients and have an impedance less than 200 ohms. For operation of more than one controller from the same external source, a source resistance under 50 ohms is recommended.

3. Trim Setpoint (Option 8)

   Requires 1-5 Vdc setpoint voltage from an external source. Source resistance up to 20 ohms. Trim control adjusts the remote setpoint ±5% of span. Typical input impedance of 20k ohms.

   A Trim Control, located in place of the Digital Setpoint, can be set to adjust the remote 1-5Vdc input setpoint signal ±5% of span. The input setpoint signal is usually trimmed to either correct for sensor differences or to select a desired temperature profile.

2.9.2 Output Setpoint Wiring (Setpoint Options 3 or 6)

NOTE:

1-5Vdc proportional to instrument setpoint span. Short circuit has no effect on control action. Source resistance less than 10 ohms.

The Series 520 operates as a Master Controller which can transmit a 1-5 Vdc output setpoint voltage to many multiple Slave Controllers.

Maximum total output current of Process Signal Output option plus Output Setpoint Voltage option is 10 mAdc.

2.10 Process Signal Wiring — Isolated

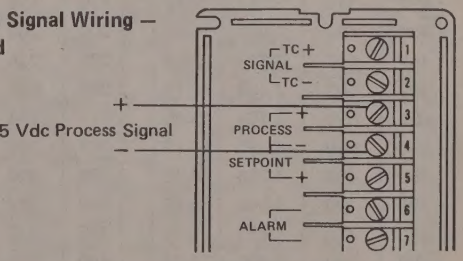


Figure 2-12. Process Signal Output Wiring (Setpoint Options 2, 3, 5, 6, 7 and 8)

NOTE

External short circuit has no effect on control action. Source resistance less than 10 ohms.

Setpoint options 2, 3, 5, 6, 7, and 8 include Interface Signal Isolation. This means that the Process Signal and Setpoint Signal Outputs are isolated from the signal input terminals. There is also Input-Output Isolation.

Cooling Limit Adjustment on Output Control Forms H, J, and K. Continuously adjustable from 5 to 100% on time.

THIS MODEL NUMBER CODE EXPLAINS THE MODEL NUMBER STAMPED ON THE CONTROLLER

WRITE THE ENTIRE 15-DIGIT CODE WHEN ORDERING

52 X X - X XXXX - XXX - X - XX

Series — 52

Control Mode
1 — ON-OFF or Limitrol (only with A, L or T below)
2 — Proportional Controller
3 — Proportional + Integral (reset)
4 — Proportional + Integral + Derivative (Rate)

Output Control Form
A — ON-OFF (only with 1 above)
B — Time Proportioning
C — Current: 2-12 mA, Reverse Acting
D — Current: 4-20 mA, Reverse Acting
E — Dual — Time proportioning and on-off auxiliary output
F — Dual — Current 2-12 mA and on-off auxiliary output
G — Dual — Current 4-20 mA and on-off auxiliary output
H — Dual — Time proportioning on both outputs
J — Dual — Current 2-12 mA and Time Proportioning auxiliary output
K — Dual — Current 4-20 mA and Time Proportioning auxiliary output
L — Limitrol (only with 1 above)
P — Current: 2-12 mA, Direct Acting
Q — Current: 4-20 mA, Direct Acting
T — Limitrol (only with 1 above)

Setpoint
1 — Analog Setpoint
2 — Analog Setpoint with Remote — Local Switch
3 — Analog Setpoint with output setpoint voltage available
4 — Digital Setpoint (standard)
5 — Digital Setpoint with Remote-Local switch
6 — Digital Setpoint with output setpoint voltage available
7 — None. Requires remote setpoint voltage
8 — Trim Setpoint. Requires remote setpoint voltage
9 — Other

Setpoint options 2, 3, 5, 6, 7 and 8 include a Process Signal Output

Range Code
Four Digit Range Code

Add zero(s) to the left of the range code to make a four digit number

Input Signal
0 — Thermocouple Upscale TCB
1 — Thermocouple Downscale TCB
2 — Resistance Bulb
4 — Vdc (above .1 Vdc)
5 — mAdc
6 — Radiation Pyrometer Emissivity Correction
8 — mVdc (below 100 mVdc)
9 — Other

Housing
0 — Panelmount (standard)
1 — Shipped without housing — order housing separately
2 — Panelmount with conduit openings and rear cover

Specify 1 above and see 1252 DB3 to order high density housings for either Panel or Standard Relay Rack.

Readouts
1 — Deviation Meter (standard)
3 — Process Meter
5 — Digital Process Meter

Alarms
0 — None (standard)
1 — Deviation Alarm
2 — Deviation Band Alarm
3 — Process Alarm

Specials

All of the models include, as standard, indicator lights appropriate to the output form selected.

CALIBRATION CHARTS, DIGITAL SETPOINT ONLY

0 TO 799°F
DIGITAL RANGE CODE 0016

True Temp °F	Dial Setting or DPM Reading	Setpoint Voltage	Input mV
0	12	1.059	-0.89
50	57	1.286	0.51
100	104	1.520	1.94
150	152	1.759	3.41
200	200	2.003	4.91
250	250	2.250	6.42
300	299	2.499	7.95
350	349	2.749	9.48
400	400	3.000	11.02
450	450	3.252	12.57
500	500	3.503	14.11
550	550	3.754	15.65
600	600	4.005	17.19
650	650	4.255	18.72
700	700	4.505	20.25
750	750	4.755	21.78
799	799	5.000	23.29

0 TO 598°F
DIGITAL RANGE CODE 0015

True Temp °F	Dial Setting or DPM Reading	Setpoint Voltage	Input mV
0	10	1.069	-0.89
25	33	1.219	-0.20
50	56	1.373	0.51
75	79	1.528	1.22
100	103	1.686	1.94
125	127	1.846	2.67
150	151	2.007	3.41
175	175	2.170	4.16
200	200	2.333	4.91
225	224	2.498	5.66
250	249	2.664	6.42
275	274	2.830	7.18
300	299	2.997	7.95
325	324	3.165	8.71
350	349	3.333	9.48
375	375	3.501	10.25
400	400	3.669	11.02
425	425	3.838	11.79
450	450	4.006	12.57
475	475	4.175	13.34
500	501	4.343	14.11
525	526	4.511	14.88
550	551	4.679	15.65
575	576	4.847	16.42
598	599	5.000	17.12

200 TO 1190°F
DIGITAL RANGE CODE 0203

True Temp °F	Dial Setting or DPM Reading	Setpoint Voltage	Input mV
200	202	1.010	4.91
250	251	1.206	6.42
300	301	1.404	7.95
350	351	1.603	9.48
400	401	1.803	11.02
450	451	2.003	12.57
500	501	2.203	14.11
550	550	2.403	15.65
600	600	2.603	17.19
650	650	2.802	18.72
700	700	3.000	20.25
750	749	3.199	21.78
800	799	3.398	23.32
850	849	3.597	24.85
900	899	3.797	26.40
950	949	3.999	27.95
1000	1000	4.202	29.52
1050	1051	4.407	31.10
1100	1103	4.616	32.71
1150	1156	4.827	34.34
1190	1199	5.000	35.67

0 TO 1999°F
DIGITAL RANGE CODE 0030

True Temp °F	Dial Setting or DPM Reading	Setpoint Voltage	Input mV
0	13	1.027	-0.69
100	109	1.217	1.52
200	208	1.415	3.82
300	305	1.611	6.09
400	401	1.803	8.31
500	498	1.996	10.56
600	597	2.194	12.85
700	697	2.394	15.18
800	798	2.596	17.52
900	899	2.800	19.88
1000	1001	3.004	22.25
1100	1103	3.208	24.62
1200	1205	3.411	26.98
1300	1305	3.612	29.31
1400	1405	3.812	31.63
1500	1504	4.009	33.91
1600	1601	4.203	36.17
1700	1696	4.394	38.39
1800	1790	4.583	40.58
1900	1883	4.768	42.73
1999	1974	4.950	44.83

Barber-Colman Company
INDUSTRIAL INSTRUMENTS DIVISION
1300 Rock Street, Rockford, Illinois, U.S.A., 61101

July, 1976

LITHO IN U.S.A.

MODELS 521, 522, 523 AND 524
MAIN BOARD CIRCUITS, AND CALIBRATION
(Includes Wiring Diagram and Replaceable Mechanical Parts)

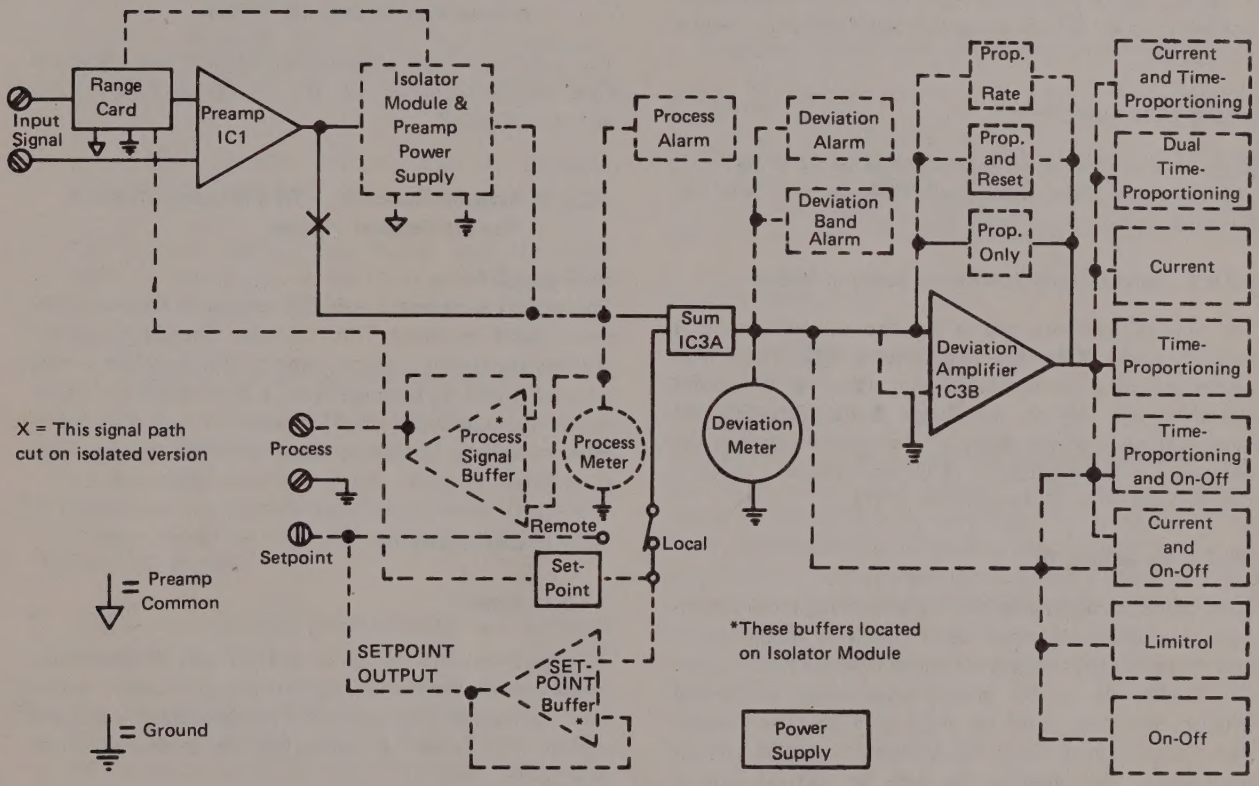


Figure 3-1. Simplified Block Diagram.

3. INTRODUCTION

3.1 General Description

Descriptions common to all models of the Series 520 are included in this section. Figures showing replaceable mechanical parts and a wiring diagram for all models are at the end of the section.

3.2 Main Board

3.2.1 OVERALL DESCRIPTION

See Figure 3-1. For a thermocouple input, the signal to the Preamplifier is the thermocouple signal minus the cold junction reference signal. The Preamplifier amplifies the direct current millivolt input signal to drive an optional process meter and an optional alarm board. When the temperature of the input thermocouple and the temperature set on the front panel setpoint are the same, the output (error signal) of the SUM network on the Main Board is zero. At zero error signal, the input to the deviation meter will be zero, and it will indicate zero deviation. Any signal other than zero is amplified by the Deviation Amplifier. Gain plus Manual Reset or Gain plus Integral plus Derivative action takes place on a separate board. The Demand Signal from the Deviation Amplifier drives the output control board. ON-OFF Control Forms such as the 520L, T, and A and Output 2 of the E, F, and G receive a driving signal directly from the Sum Amplifier output (deviation signal).

3.2.2 CIRCUIT DESCRIPTION

See Schematic Figure 3-3.

3.2.2.1 Preamplifier IC1

The gain is fixed by resistors R6 and R7 on the Range Board. The output of IC1 on pin 10 which ranges from 2 to 10 Vdc is the amplified process signal. This process signal drives the front panel process meter, and also appears on rear panel terminals 3 and 4.

R8 and R9 on the Isolator Board divides the 2 to 10 Vdc down to 1 to 5 Vdc. IC2B is a buffer stage that prevents instrument control from being affected if terminals 3 and 4 are shorted.

3.2.2.2 IC3A Sum

IC3A on the Main Board sums the process signal with the setpoint signal. The output of IC3A on pin 1 is the deviation signal.

3.2.2.3 Current Source IC4 for the Setpoint Voltage

The voltage reference source for the current source is resistor divider R20, R21 and trimpot R22. The 5 Vdc reference voltage is connected across the digital setpoint resistance and R9 on the Range Board. Changing the numerical value of the digits on the setpoint changes the resistance in the emitter leg of Q2 and generates the 1–5 Vdc setpoint signal in the collector of Q2.

3.2.2.4 Op Amp IC3B

IC3B is the deviation amplifier for amplifying the deviation signal to supply a demand signal. The gain adjustment is R23. When manual reset is furnished with the Proportional only Control Mode, the manual reset voltage is summed with the deviation signal on pin 5 of IC3B. The demand signal output on pin 7 of IC3A drives the output control form board. The amplifier also sums the correction signal from either the PI or PID boards.

3.2.2.5 Power Supplies +15 Vdc, -15 Vdc & -30 Vdc

The -30 Vdc supply has only its transformer on the Main Board. The remainder of its circuit is on any output control form board with a current output. The ac voltage from the transformer is on pins 10 and 11 of P5. The +15 Vdc potential is established by IC2 which is an integrated circuit regulator. The +15 Vdc voltage is adjusted by R18. Zener diode D5 and series pass transistor Q1 provides the regulation for the -15 Vdc supply.

3.2.2.6 Setpoint Options 1 and 4: – Setpoint Only

This is the internal setpoint only. Option 4 is standard.

3.2.2.7 Setpoint Options 2 and 5: – Setpoint With Remote Local Switch

This simple circuit switches between remote and internal terminals. The 1–5 Vdc remote setpoint signal is filtered by R30 and C14 and then summed with the process signal from IC1A on the Isolation Board.

3.2.2.8 Setpoint Options 3 and 6: – Setpoint With Output Setpoint Voltage Available

IC3 on Isolation Board is a buffer with a low output impedance. IC3 prevents loss of control action should rear panel terminals 4 and 5 be shorted.

3.2.2.9 Setpoint Option 7: – No Built-in Setpoint, Accepts Remote Setpoint Voltage

The 1–5 Vdc remote setpoint signal is filtered by R30 and C14, and then summed with the process signal from IC1A of Isolation Board.

3.2.2.10 Setpoint Option 8: – Trim Setpoint. Requires Remote Setpoint Voltage

See Figure 3-4.
This option is on board A-10278 located on the rear of the front panel mounted Trim Control. The Trim Control replaces the standard digital setpoint. The 1–5 Vdc remote setpoint signal is summed with a trim setpoint voltage, which is at a potential of ±5% of setpoint span. This "new" setpoint voltage is then summed with the process signal from IC1A.

3.2.3 CALIBRATION

3.2.3.1 General

All adjustments are factory set and normally do not require readjustment. Verification of instrument accuracy within specifications, or determination if recalibration is necessary, can be determined by performing the calibration check procedures.

3.2.3.2 Calibration Equipment

The following equipment is required to calibrate this controller:

1. Differential Voltmeter with 10 mV full scale or less such as Fluke Model 871AB or a Portable Potentiometer such as the Barber-Colman Model PA11-1. Hewlett-Packard Model 427A.

2. Dc millivolt source with outputs of 0–1 mVdc and 0–100 mVdc. Source resistance must be 50 ohms or less.

3. Extender assembly 24-2 for Calibration or Troubleshooting.

Proceed through the following paragraphs in order. Do not skip a paragraph.

3.2.3.3 Calibration Check

THE EXAMPLES IN THIS CALIBRATION CHECK IN PARENTHESES ARE FOR RANGE CODE 0030 (0 to 2000° F, TYPE K).

1. Connect a millivolt source to the sensor input terminals. If the sensor is a thermocouple, be certain the correct thermocouple extension wire is used.

2. Set the millivolt source to the value shown in the Calibration Table for mid-scale temperature. (Example: 1000°F=22.25mV).

3. Connect a precision voltmeter to read the deviation voltage. Positive probe to pin 1 of P5, negative probe to pin 7 of P5.

4. Adjust the controller setpoint until the deviation voltage is 0 ± .025Vdc.

5. The setpoint reading must agree with the "Dial Setting" value shown in the Calibration Table within the rated accuracy of the instrument. (Example: 1001±20).

   ±1% of span plus 0.5% of suppression.

6. Set the millivolt source to the millivolt value corresponding to a temperature which is listed in the Calibration Table and which falls between 10 and 20% of span above the low point of the range. (Example: 200°F=3.82mV).

7. Adjust the controller setpoint until the deviation voltage is 0±.025Vdc.

8. The setpoint reading must agree with the "Dial Setting" value shown in the Calibration Table within the rated accuracy of the instrument. (Example: 208±20).

9. Set the millivolt source to the millivolt value corresponding to a temperature which is listed in the Calibration Table and which falls between 80 and 90% of span above the low point of the range. (Example: 1800°F=40.58mV).

10. Adjust the controller setpoint until the deviation voltage is 0±.025Vdc.

11. The setpoint reading must agree with the "Dial Setting" value shown in the Calibration Table within the rated accuracy of the instrument. (Example: 1790±20).

    ±1% of span plus 0.5% of suppression.

12. If the controller meets the accuracy specifications in steps 5, 8, and 11, the controller is properly calibrated. Do not make any internal adjustments or proceed further in the calibration procedure.

13. If the controller fails to meet the accuracy specifications in either step 5, 8, or 11, the controller must be calibrated.

Table 3-1 lists the adjustments on the Main Board. Always perform the adjustments on the Main Board first. When a Range Board is replaced, readjust R8 and R22 on the Main Board. After replacing either a Process Meter, or a Deviation Meter, readjust R10 on the Main Board.

If any repairs are made, all the adjustments on the Main Board, Control Mode Board (if any) and Output Board (if any) must be made.

Table 3-1. Summary of Adjustments on Main Board

Symbol	Description
R18	+15 Vdc Supply
R22	3 Vdc Setpoint Voltage (MID SPAN)
R8	6 Vdc Process Signal (MID SPAN)
R10	Process Meter Span or Deviation Meter Span

3.2.3.4 Meter Zero

Both the Process and Deviation Meters have a mechanical zero adjustment on the top of the meter. It is covered by tape. Remove the tape.

For the Deviation Meter with the instrument vertical, zero the meter with a non-magnetic screwdriver, and replace the tape. After a Deviation Meter is zeroed, place the instrument in the panel and be sure the meter is still at zero. This detects if any magnetic flux in the panel is present to offset the meter — if the meter is offset, zero it in the panel.

Apply 1Vdc across the terminals of the Process Meter before zeroing it.

Replace the tape.

3.2.3.5 ±15 Vdc Supply

A voltmeter capable of reading voltages to five significant figures in the range of 0–16 Vdc is required. Assuming such a voltmeter is available, proceed as follows:

1. Turn power on to the Series 520.

2. Set the voltmeter to read up to 16.000 Vdc.

3. Connect the probes of the voltmeter across the 15 Vdc supply (positive probe to pin 11 of P2, negative probe to pin 10). To locate these pins look at P2 on the Range Board. There are 11 pins on P2, and they are numbered 1 through 11, from left to right.

4. Adjust R18 until 15.000 Vdc±.015 Vdc is obtained.

5. Remove the probes.

6. Seal R18.

7. The -15 Vdc supply can be measured between pins 5 and 7 of P5 Output Board. Connect the positive probe to pin 7 and the negative probe to pin 5. The voltage read should not be less than 13.650 Vdc or more than 15.150 Vdc. To locate these pins first look at the board parts location drawing in the Output section of this manual.

8. Allow power to remain on to the instrument.

3.2.3.6 Setpoint

3.2.3.6.1 Digital

1. Turn the front panel SETPOINT ADJUST control to mid span of the setpoint range. (Example: 1000°F).

2. Set the voltmeter to read up to 4.000 Vdc.

3. Connect the positive probe of the voltmeter to pin 1 of P2 and the negative probe of the voltmeter to pin 10 of P2.

4. Adjust R22 until 3.000 Vdc±.003 Vdc is obtained.

5. Seal R22.

6. Allow power to remain on to the instrument.

3.2.3.6.2 Analog

1. Connect the positive probe of the voltmeter to the blue wire on the Analog Setpoint Board A-10503. Connect the negative probe to pin 10 of P2 on the Range Board.

2. Remove the setpoint knob.

3. Turn the SETPOINT ADJUST Control fully CCW. Observe the reading on the voltmeter. Slowly turn the SETPOINT ADJUST Control CW until a 25 mVdc change is observed on the voltmeter.

4. Reinstall the setpoint knob. Carefully align the pointer to the lowest scale value.

5. Adjust R5 on the Setpoint Board A-10503 for 1.000 Vdc±1 mVdc.

6. Turn the SETPOINT ADJUST Control fullscale.

7. Adjust R2 on the Setpoint Board for 5.000 Vdc±5 mVdc.

8. Repeat steps 5 through 7.

3.2.3.7 Deviation Signal Null

1. Adjust the front panel SETPOINT ADJUST control to the setting on the Calibration Table that corresponds to the midspan of the instrument. (Not necessarily the same as midspan of setpoint) (Example: 1001 setting = 1000°F).

2. Connect the dc millivolt source to input terminals 1 and 2. Be certain the polarity of the connections is correct.

3. Adjust the D.C. millivolt source for the equivalent millivolts of the same midscale temperature used in step 1. (Example: 1000°F=22.25mV).

4. Measure the deviation output of IC3A as follows: Connect the positive probe to pin 1 of P5, and the negative probe to pin 7 of P5. The precision voltmeter should read 0 Vdc ±.025 Vdc. Adjust R8 for zero deviation.

5. Seal R8, if Isolation Board is not present.

6. Allow power to remain on to the instrument.

7. If Isolation Board is installed, proceed to Isolation Board Adjustments and lastly do the Meter Span Adjustment.

3.2.3.8 Meter Span

If the controller has a Deviation Meter set the input source for the equivalent of midscale temperature and adjust the setpoint for the maximum deviation that corresponds to the deviation meter scale. For example, assume the controller has a 0 to 400°F range and a Deviation Meter with a scale marked -30 to 0 to +30. Adjust the setpoint to 230°F. Deviation Meter should read -30° to within one major division. Adjust R10 if it does not. Next, adjust the setpoint to 170°F. Deviation Meter should read +30°F to within one major division. Adjust R10 if it does not.

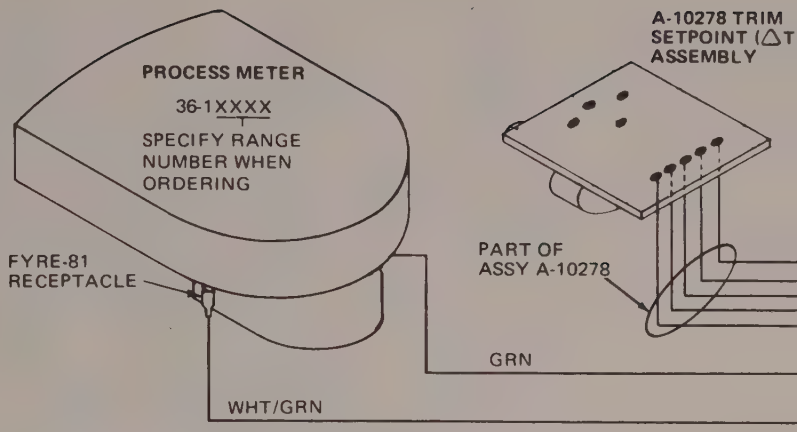
If the controller has a process meter, it should be indicating mid span when the dc millivolt source is set for the equivalent of midscale temperature. If it does not, adjust R10 until it does.

Allow power to remain on to the instrument and next perform any adjustments (if any) for the Control Mode and Output Sections, respectively, of this manual.

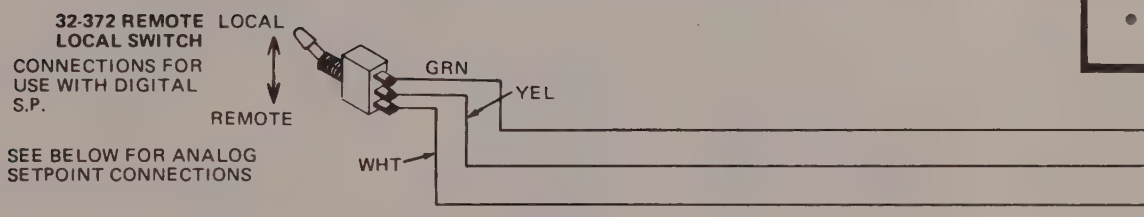
Table 3-2. Complete Main Board Assemblies

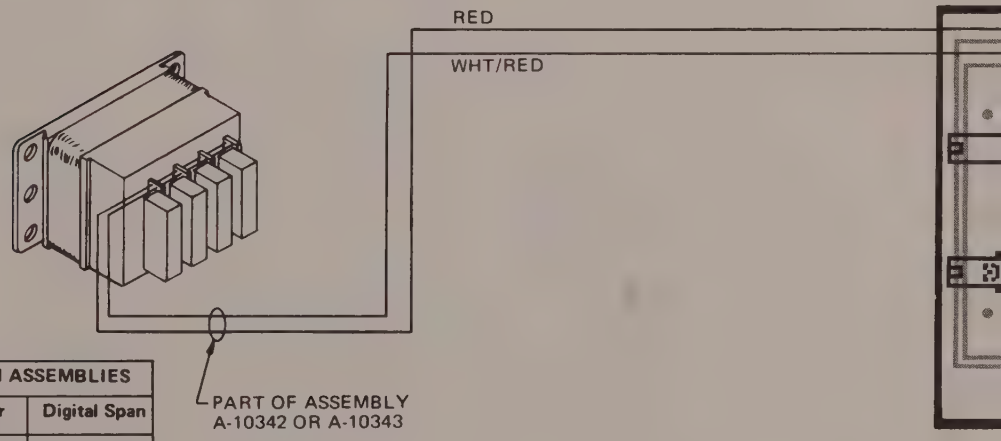
Assembly Number	Setpoint Option	Description of Feature Making Board Different from Other Main Boards
A-11410-100	4	Digital Setpoint
A-11410-200	5	Digital Setpoint with Remote–Local Switch
A-11410-300	6	Digital Setpoint with output setpoint voltage
A-11410-400	7	No setpoint. Requires remote setpoint voltage.
A-11410-500	8	Trim Setpoint. Requires remote setpoint voltage.
A-11410-600	1	Analog Setpoint
A-11410-700	2	Analog Setpoint with Remote–Local Switch
A-11410-800	3	Analog Setpoint with output setpoint voltage

Deviation Meter Part Numbers		
Part Number	Scale	Span (Units)
36-093-100	50-0-50	401-800
36-093-200	30-0-30	400 or less
36-093-300	100-0-100	801-1600
36-093-400	200-0-200	1601-3000
36-093	10-0-10	% Deviation

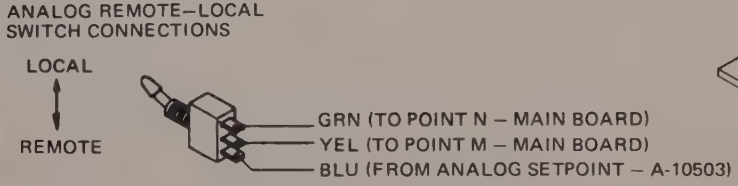


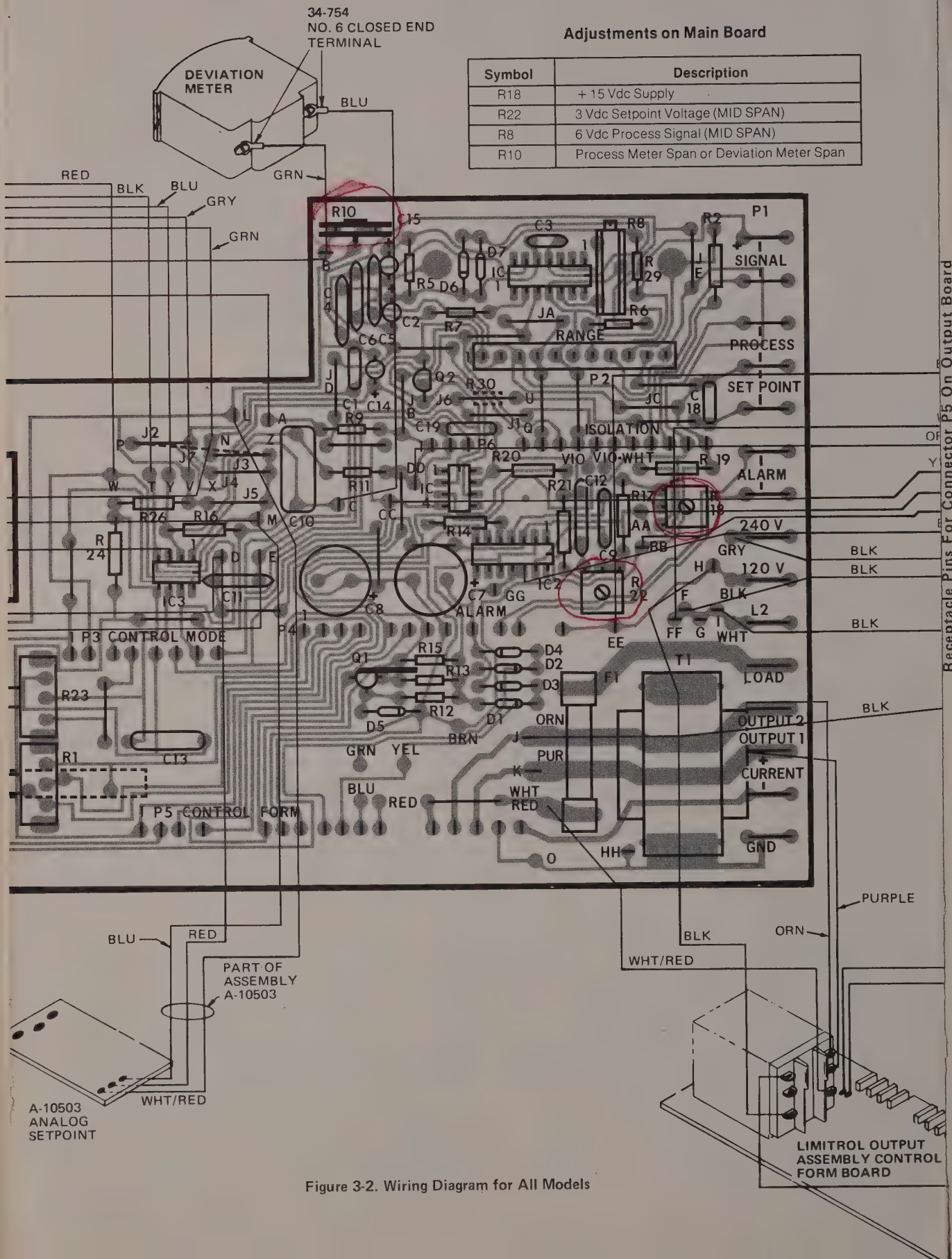
PROCESS METER PART NUMBERS
PROCESS METER ASSEMBLY 36-1 XXXX
RANGE CODE OF INSTRUMENT





SETPOINT SWITCH ASSEMBLIES		
Digits	Part Number	Digital Span
3	A-10342-100	0–X99
3	A-10342-200	200-X1199
3	A-10342-300	500-X1499
4	A-10343	0-X999
3	A-10342-400	1300-2399


ANALOG REMOTE–LOCAL SWITCH CONNECTIONS
LOCAL
REMOTE
GRN (TO POINT N – MAIN BOARD)
YEL (TO POINT M – MAIN BOARD)
BLU (FROM ANALOG SETPOINT – A-10503)



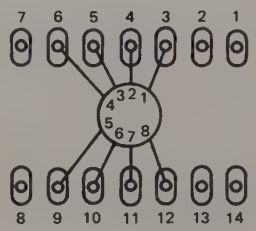
Adjustments on Main Board

Symbol	Description
R18	+ 15 Vdc Supply
R22	3 Vdc Setpoint Voltage (MID SPAN)
R8	6 Vdc Process Signal (MID SPAN)
R10	Process Meter Span or Deviation Meter Span

Figure 3-2. Wiring Diagram for All Models

Table 3-3. Main Boards, Parts List

Symbol	Part Number	Description
	CAPACITORS	
C1	CYZR-803	.1μF 20%, 250WVDC
C2,15	39-414	22μF 10%, 15 WVDC
C3	39-387	500ρF 20%, 100 WVDC
C4,6	39-325	.05μF 20%, 100 WVDC
C5	39-103	.01μF 6 GMV, 100 WVDC
C7,8	39-163	100μF +100 -10%, 50 WVDC, Electrolytic
C9	39-069	100μF 5%, 600 WVDC
C10	CYZR-824	1ρF 20%, 100 WVDC
C11,12.19	39-449	.047μF 10%, 250 WVDC
C13	39-433	.22μF 10%, 250 WVDC
C14	39-400	10μF 20%, 15 WVDC (Only on A-11410-200, 400, & -700)
C18	39-449	.047μF 10%, 250 WVDC (Only on A-11410-300, -800)
	DIODES	
D1,2,3, 4,6,7	EYZP-384	Silicon, 250 PIV, 100 mA (Transition SG3087)
D5	37-204	Zener, 15V 5%, 400 mW
	FUSE	
F1	50-1223	20 Ampere, Type AGC 20 (Model 521L and 521T)
	SYZE-206	2 Ampere, Type AGC-2 (All other models)
	INTEGRATED CIRCUITS	
IC1	31-1011 or 31-1014	725C Operational Amplifier
IC2	31-1010	723C Voltage Regulator
IC3	31-1015 Dual	741C Minidip Operational Amplifier
IC4	31-1012	741C Minidip Operational Amplifier (omit on A-11410-600, -700, & -800)
	WIRE JUMPERS	
J1	Only on A-11410-300 & -800	
J2	Only on A-11410-300	
J3	Only on A-11410-400	
J4	Only on A-11410-100 & -300	
J5	Only on A-11410-500	
J6	Only on A-11410-300, -500 and -800	
J7	Only on A-11410-800	
	TRANSISTOR	
Q1	31-162	HS5819
Q2	EYZP-623	2N4126 (omit on A-11410-600, -700, & -800)
	RESISTORS	
Resistors are 10% tolerance, 1/4W, unless otherwise stated.		
R1	29-380	Process ALARM Potentiometer: 50k ohms, 3/4W
R1	29-374	Deviation ALARM Potentiometer: 5k ohms 20%
R2	MYDA-29-60	100 ohms 1%
R5,29	CYZR-861-230	2k ohms 1%, 1/8W
R6	CYZR-861-259	4.02k ohms 1%, 1/8W
R7	40-1751	47 ohms
R8	29-220	Variable, 100k ohms, 3/4W
R9	40-1922	6.8k ohms
R10	BYZR-162-5	Variable, 3k ohms 30%
R11	CYZR-861-330	20k ohms 1%, 1/8W
R12	CYZR-481-150	1.5k ohms
R13	CYZR-466	150 ohms
R14	CYZR-862-218	2.5k ohms 1%
R15	CYZR-481-350	4.7 ohms
R16	CYZR-862-330	20k ohms 1%
R17	CYZR-864-251	33.2k ohms .5%, 1/8W
R18	29-383	Variable, 1k ohm 20%, 1/2W
R19	CYZR-864-247	3.01k ohms .5%, 1/8W
R20	CYZR-864-268	4.99k ohms .5%, 1/8W
R21	CYZR-864-295	9.53k ohms .5%, 1/8W
R22	29-383	Variable, 1k ohm 20%, 1/2W
R23	29-370	GAIN Potentiometer, 25k ohms 30%
R24,26	CYZR-862-268	4.99k ohms 1%
R30	CYZR-861-301	10K ohms 1%, 1/8 W (Only on A-11410-200, -400, & -700)
	TRANSFORMER	
T1	30-346-2	Power



View for Installing 31-1011 (Round Can IC) In Place Of 31-1014 (D.I.P.)

For Continuation of Circuit See Figure 3-3.

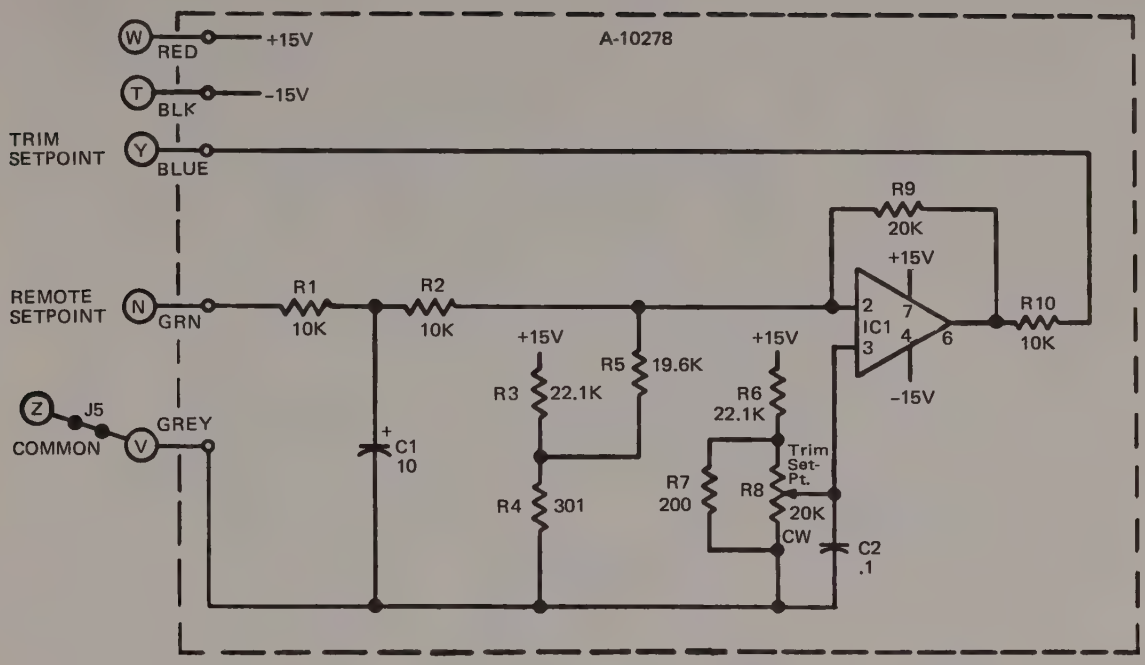
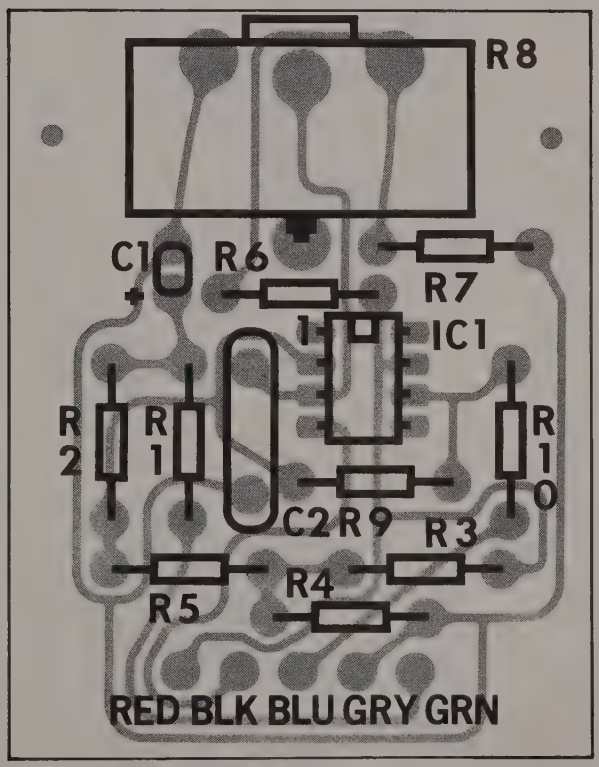


Table 3-4. Trim Setpoint Board A-10278 Parts List

Symbol	Part Number	Description
	CAPACITORS	
C1	39-400	10μF, 20%, 15 WVDC
C2	CYZR-803	.1μF, 10%, 250 WVDC
	INTEGRATED CIRCUIT	
IC1	31-1012	741C
	RESISTORS	
Resistors are 1%, 1/8W, unless stated otherwise.		
R1,2, 10	CYZR-861-301	10k ohms
R3,6	CYZR-861-334	22.1k ohms
R4	CYZR-861-147	301 ohms
R5	CYZR-861-329	19.6k ohms
R7	CYZR-861-130	200 ohms
R8	29-386	Variable, 20k ohms, 10%, 2W, W.W., TRIM Control
R9	CYZR-861-330	20k ohms



This board is located on the rear of the front panel mounted trim control.

Figure 3-4. Trim Setpoint Board and Schematic

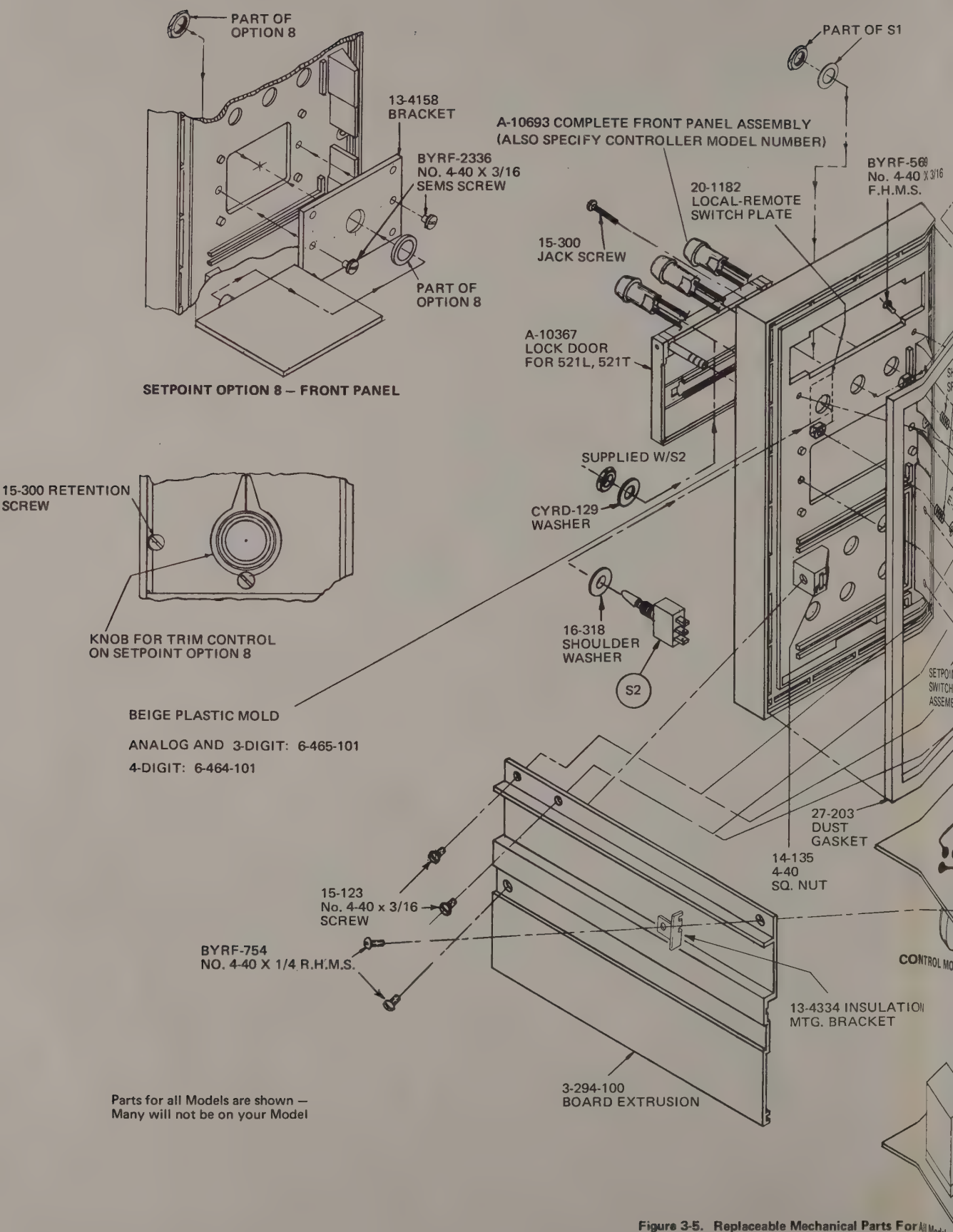
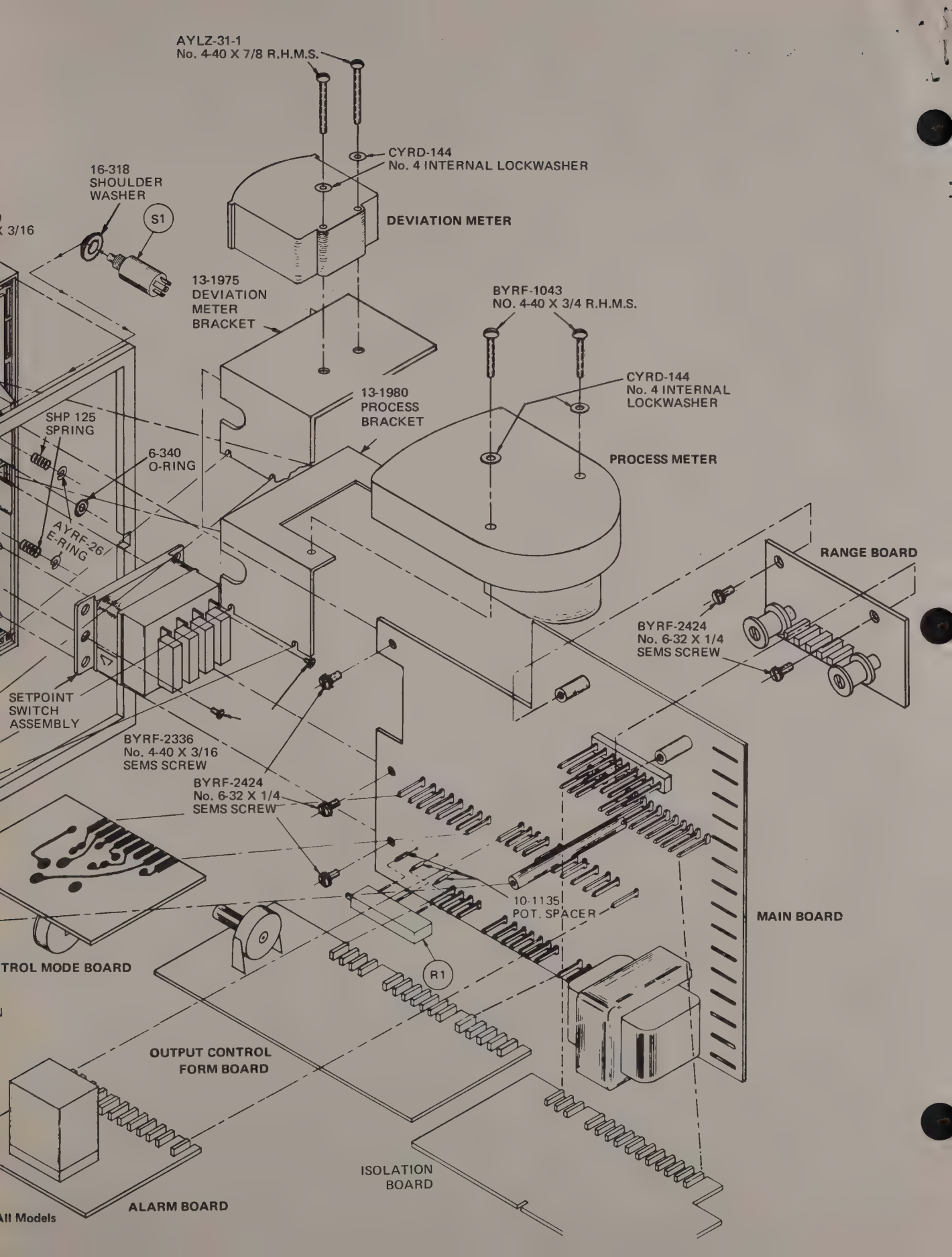

PART OF OPTION 8
13-4158 BRACKET
BYRF-2336 NO. 4-40 X 3/16 SEMS SCREW
PART OF OPTION 8
SETPOINT OPTION 8 – FRONT PANEL
PART OF S1
A-10693 COMPLETE FRONT PANEL ASSEMBLY (ALSO SPECIFY CONTROLLER MODEL NUMBER)
BYRF-568 No. 4-40 X 3/16 F.H.M.S.
20-1182 LOCAL-REMOTE SWITCH PLATE
15-300 JACK SCREW
A-10367 LOCK DOOR FOR 521L, 521T
SUPPLIED W/S2
CYRD-129 WASHER
15-300 RETENTION SCREW
KNOB FOR TRIM CONTROL ON SETPOINT OPTION 8
16-318 SHOULDER WASHER
S2
BEIGE PLASTIC MOLD
ANALOG AND 3-DIGIT: 6-465-101
4-DIGIT: 6-464-101
27-203 DUST GASKET
14-135 4-40 SQ. NUT
15-123 No. 4-40 x 3/16 SCREW
BYRF-754 NO. 4-40 X 1/4 R.H.M.S.
13-4334 INSULATION MTG. BRACKET
3-294-100 BOARD EXTRUSION
Parts for all Models are shown – Many will not be on your Model

Figure 3-5. Replaceable Mechanical Parts For All Models


AYLZ-31-1
No. 4-40 X 7/8 R.H.M.S.
CYRD-144
No. 4 INTERNAL LOCKWASHER
16-318
SHOULDER
WASHER
S1
DEVIATION METER
13-1975
DEVIATION
METER
BRACKET
BYRF-1043
NO. 4-40 X 3/4 R.H.M.S.
CYRD-144
No. 4 INTERNAL
LOCKWASHER
13-1980
PROCESS
BRACKET
PROCESS METER
SHP 125
SPRING
6-340
O-RING
AYRF-26
E-RING
RANGE BOARD
BYRF-2424
No. 6-32 X 1/4
SEMS SCREW
SETPOINT
SWITCH
ASSEMBLY
BYRF-2336
No. 4-40 X 3/16
SEMS SCREW
BYRF-2424
No. 6-32 X 1/4
SEMS SCREW
10-1135
POT. SPACER
MAIN BOARD
R1
OUTPUT CONTROL
FORM BOARD
ISOLATION
BOARD
ALARM BOARD

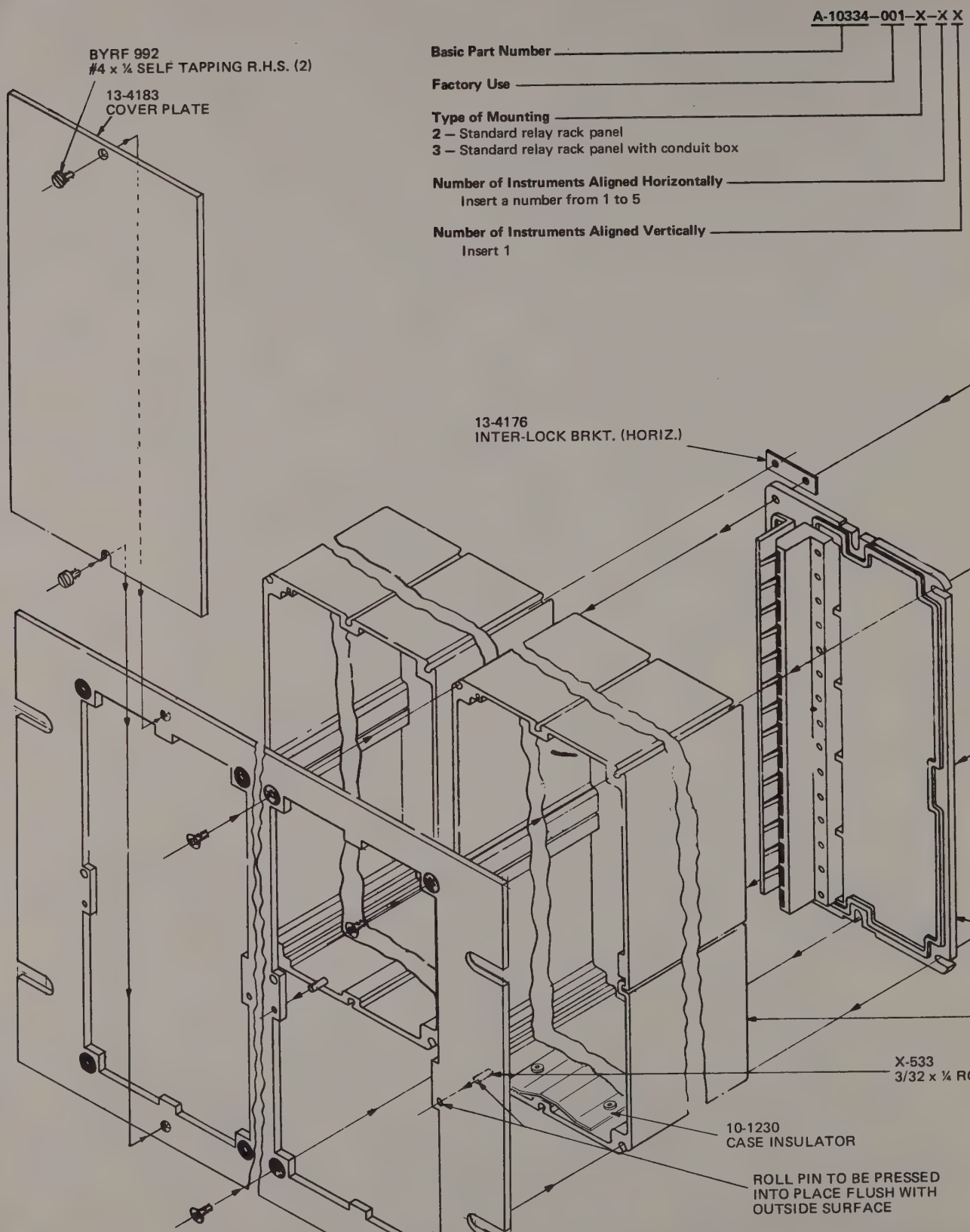


Figure 3-6. Replaceable Parts, Housings for Standard Relay Rack

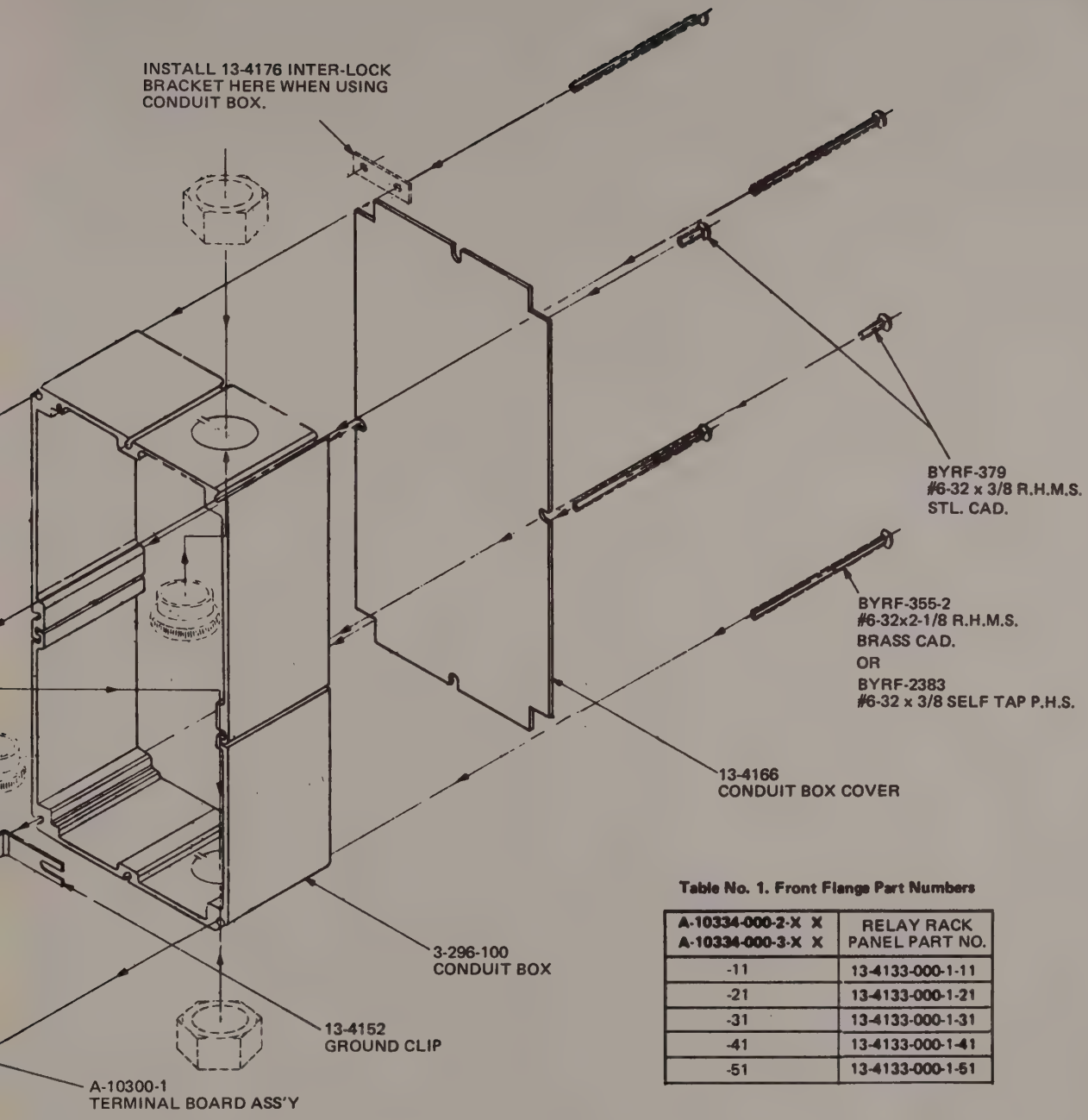


Table No. 1. Front Flange Part Numbers

A-10334-000-2-X X A-10334-000-3-X X	RELAY RACK PANEL PART NO.
-11	13-4133-000-1-11
-21	13-4133-000-1-21
-31	13-4133-000-1-31
-41	13-4133-000-1-41
-51	13-4133-000-1-51

TEM 2 (CASE FLANGE)
) APPLY A BEAD OF
OUND EACH CASE NEXT
PROVIDING A DUST SEAL.

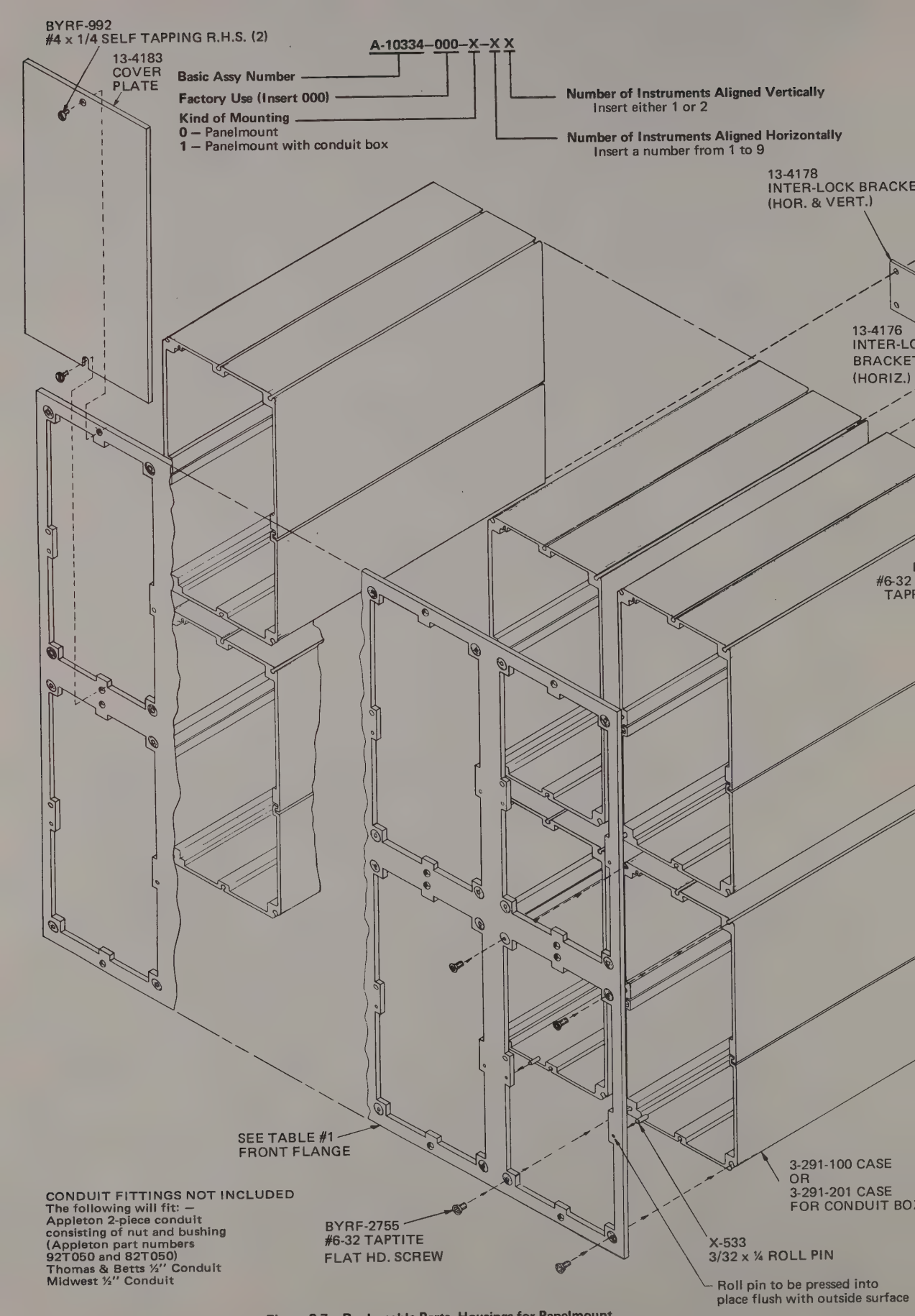


Figure 3-7. Replaceable Parts, Housings for Panelmount

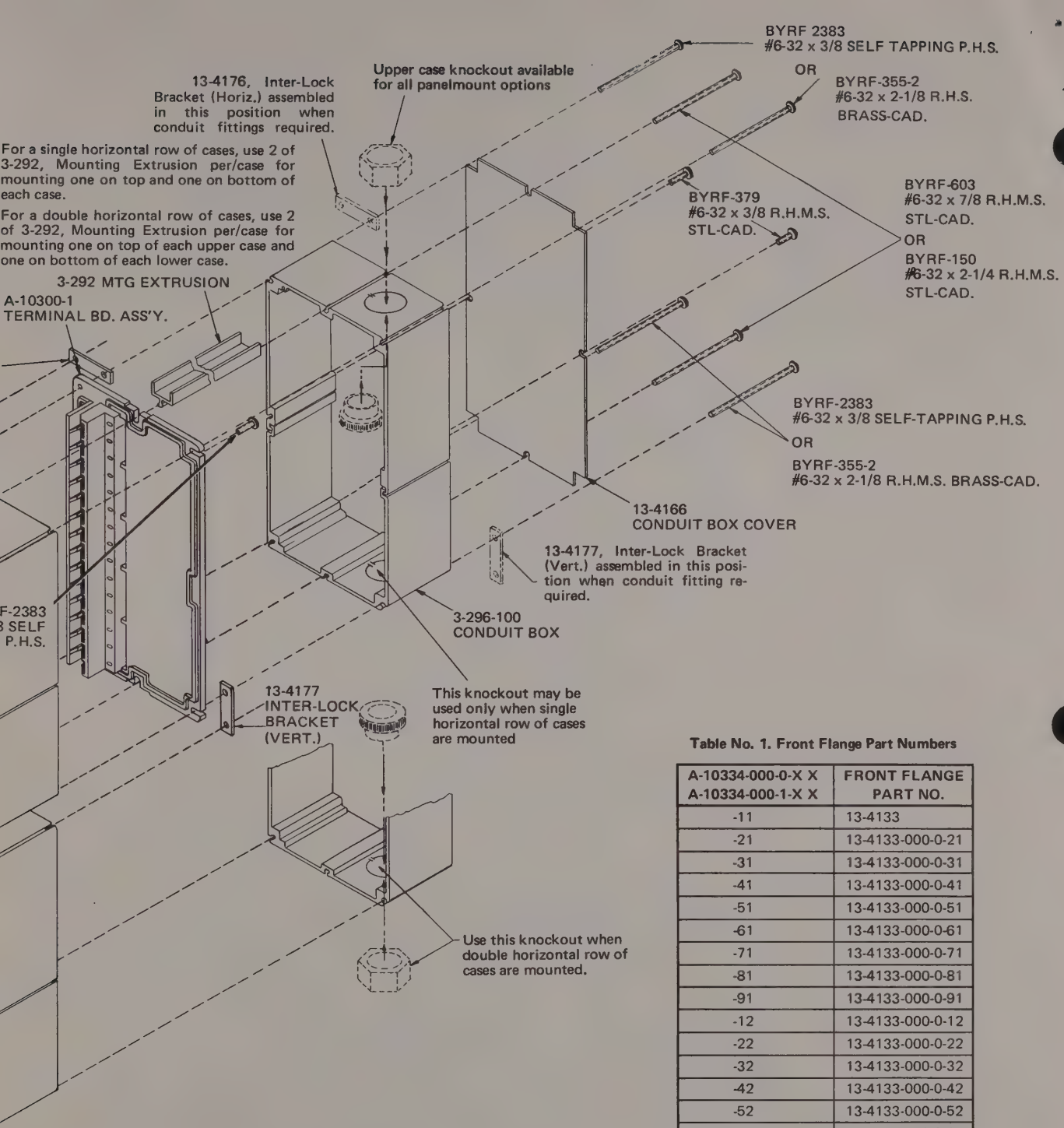

BYRF 2383
#6-32 x 3/8 SELF TAPPING P.H.S.
OR
BYRF-355-2
#6-32 x 2-1/8 R.H.S.
BRASS-CAD.
Upper case knockout available for all panelmount options
13-4176, Inter-Lock Bracket (Horiz.) assembled in this position when conduit fittings required.
For a single horizontal row of cases, use 2 of 3-292, Mounting Extrusion per/case for mounting one on top and one on bottom of each case.
For a double horizontal row of cases, use 2 of 3-292, Mounting Extrusion per/case for mounting one on top of each upper case and one on bottom of each lower case.
BYRF-379
#6-32 x 3/8 R.H.M.S.
STL-CAD.
BYRF-603
#6-32 x 7/8 R.H.M.S.
STL-CAD.
OR
BYRF-150
#6-32 x 2-1/4 R.H.M.S.
STL-CAD.
3-292 MTG EXTRUSION
A-10300-1
TERMINAL BD. ASS'Y.
BYRF-2383
#6-32 x 3/8 SELF-TAPPING P.H.S.
OR
BYRF-355-2
#6-32 x 2-1/8 R.H.M.S. BRASS-CAD.
13-4166
CONDUIT BOX COVER
13-4177, Inter-Lock Bracket (Vert.) assembled in this position when conduit fitting required.
F-2383
SELF
P.H.S.
3-296-100
CONDUIT BOX
13-4177
INTER-LOCK
BRACKET
(VERT.)
This knockout may be used only when single horizontal row of cases are mounted
Use this knockout when double horizontal row of cases are mounted.

Table No. 1. Front Flange Part Numbers

A-10334-000-0-X X A-10334-000-1-X X	FRONT FLANGE PART NO.
-11	13-4133
-21	13-4133-000-0-21
-31	13-4133-000-0-31
-41	13-4133-000-0-41
-51	13-4133-000-0-51
-61	13-4133-000-0-61
-71	13-4133-000-0-71
-81	13-4133-000-0-81
-91	13-4133-000-0-91
-12	13-4133-000-0-12
-22	13-4133-000-0-22
-32	13-4133-000-0-32
-42	13-4133-000-0-42
-52	13-4133-000-0-52
-62	13-4133-000-0-62
-72	13-4133-000-0-72
-82	13-4133-000-0-82
-92	13-4133-000-0-92

Barber-Colman Company
INDUSTRIAL INSTRUMENTS DIVISION
1300 Rock Street, Rockford, Illinois, U.S.A., 61101

DIGITAL INDICATOR SUPPLEMENT

To F-14851 for the Models 521, 522, 523, and 524; and to F-15098 for the Models 525, 526, 527, and 528.

The D-I (Digital Indicator) is on the horizontal board about 4 by 5 inches located at the upper front of the 520 Series Controller. The power transformer for the Digital Indicator is mounted under the D-I board.

OPERATION OF THE DIGITAL PROCESS METER

The digital process meter uses a well-known and proven method of analog to digital conversion known as dual slope integration. A block diagram of a dual slope integrating converter is shown in Figure 1.

TYPICAL CYCLE

Initially the output of the integrator is 0.6 volt negative. The counter is reset, and the integrator input is switched to the process signal input (Vin). The integrator's output begins to rise (Figure 2). As the ramp (integrator output) passes through zero, the zero detector changes state. This allows the control logic to send pulses into the counter. When the counter reaches its maximum count (10,000), it tumbles over to zero. At this point, the control logic switches a fixed reference voltage (Vref) to the integrator input. This opens the circuit from the process signal input and starts pulses to the counter. Vref being opposite in polarity to Vin, causes the integrator output to decrease. As the ramp passes through zero, the zero detector changes state, causing the control logic to strobe the accumulated count into the display latches. This number is proportional to the process signal input, Vin, and is displayed on the digital readout. The counter continues counting to 10,000 and the ramp continues decreasing until 0.6 volts negative is reached. This process is repeated approximately every 2 seconds.

Since Vref and No (10,000) are fixed, N (display counts) is directly proportional to Vin. The slope due to Vref is also constant. As Vin varies from 2 to 10 volts, N will vary from minimum to maximum of the temperature span of the 520 Series instrument used.

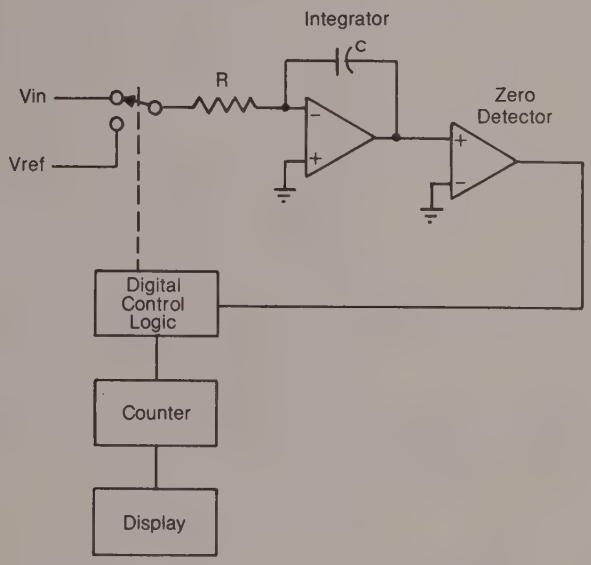


Figure 1.
Block Diagram of Dual Slope A to D Converter

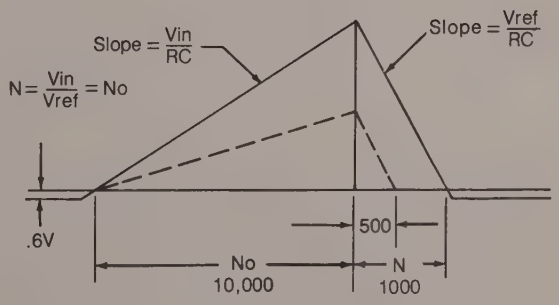


Figure 2. Integrator Output

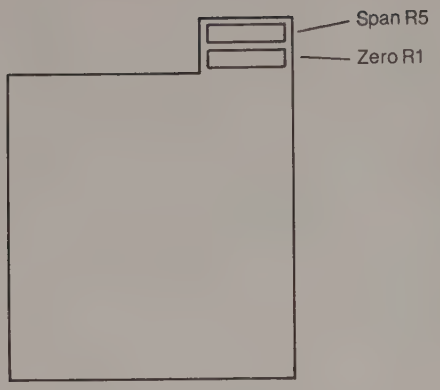


Figure 3. Location of Zero and Span Adjustments

FIELD CALIBRATION PROCEDURE

The following equipment is required.

PA11 Portable Potentiometer, or equivalent millivolt source.

Extender Assembly 24-2 (Models 521, 2, 3, 4) or 24-3 (Models 525, 6, 7, 8).

Range Code Calibration Chart SP14-X-XXXX-XXX.

Proceed as follows:

1. Connect the d-c millivolt source to input terminals 1 and 2 of the 520. Be certain the polarity of the connections is correct.

2. Slide the 520 series controller from its case. Slide extender assembly into case. Attach controller to extender assembly.

3. Turn power on to controller.

4. Adjust the d-c millivolt source for the equivalent of about 20% of the range temperature. Observe cold junction compensation procedure. Select this point from the calibration chart.

5. Adjust ZERO pot R1 until the LED display indicates the DPM reading (last column on chart) on the calibration chart for the temperature of step 4 within 1 digit.

6. Adjust the d-c millivolt source for the equivalent of about 80% of the range temperature. Observe cold junction compensation procedure.

7. Adjust the SPAN pot R5 until the LED display indicates the DPM reading on the calibration chart for the temperature of step 6 within plus or minus one digit.

8. There is an interaction between adjustments. Repeat steps 4, 5, 6, and 7, until further readjustment is not necessary.

9. Seal R1 and R5.

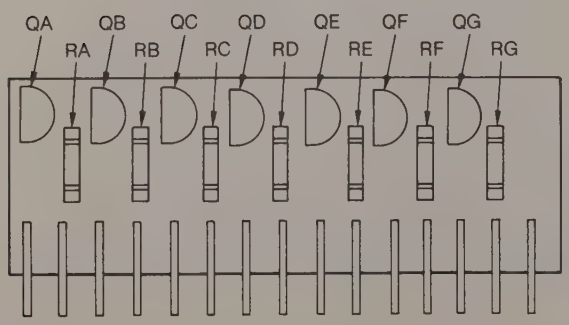


Figure 4. NW-1 Board A-10738, Parts Location

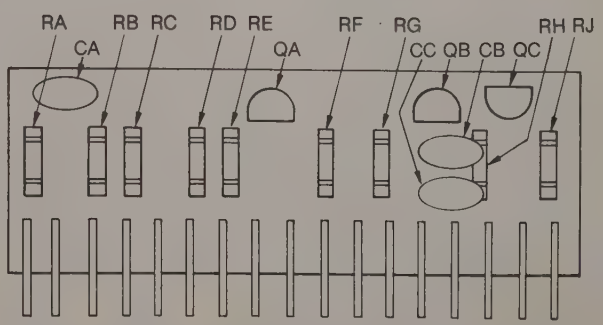


Figure 5. NW-2 Board A-10739, Parts Location

Board Order Code

DA01-X XXXX -1

Input
0—Calibrated to Range
1—3 digit Display, Uncalibrated
2—4 digit Display, Uncalibrated
3—3 Digit Universal 0–999

Range Code
0000—Uncalibrated
1—9998 from master code
9999—Multiple display with differing ranges

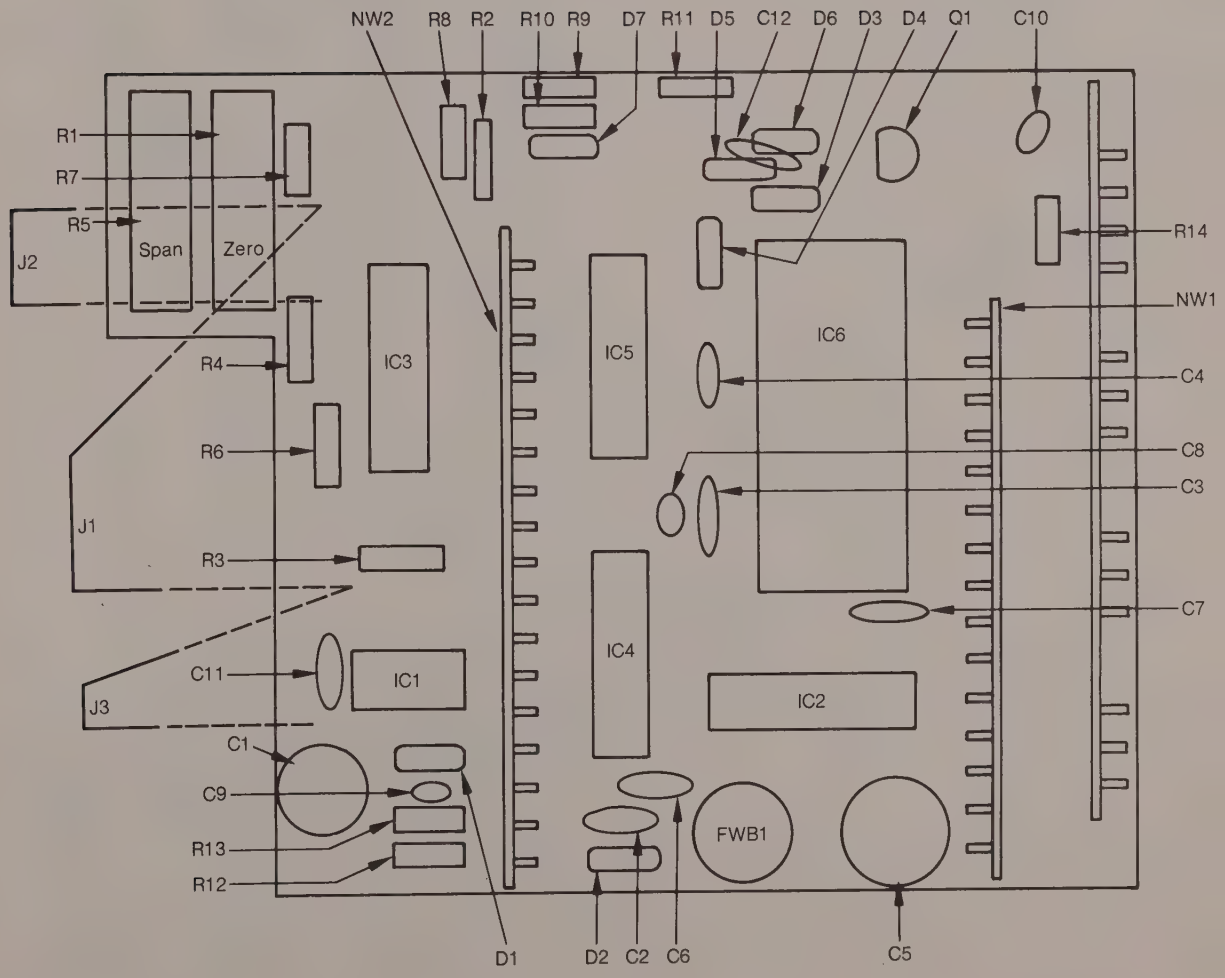


Figure 9. Digital Indicator Board DA01-XXXXX, Parts Location

PARTS LIST, HYBRID NETWORK NW-1 A-10738

Item	Part No.	Description
RA thru RG	CYZR-836-81	68 ohms, 1/4W, ±10%
QA thru QG	EYZP-623	Silicon, PNP, 2N4146

PARTS LIST, HYBRID NETWORK NW-2 A-10739

Item	Part No.	Description
RA,RC,RD	40-1847	47k, 1/4W, ±10%
RB,RE,RF, RG,RH	CYZR-481-150	1.5k, 1/4W, ±10%
RJ	40-1314	100k, 1/4W, ±10%
CA,CB	39-063	.001uF, GMV
CC	39-076	250pF, GMV
QA,QB,QC	EYZP-623	Silicon, PNP, 2N4126

PARTS LIST, MAIN BOARD DA01-XXXXX

Item	Part No.	Description
C1	39-455	1uF, 50V, ±20%
C2	39-076	250pF, 500V, ±20%
C3	E13-57	.005uF, 100V, GMV
C4	39-468	.0047uF, 50V, ±20%
C5	39-454	100uF, 10V, 100%–0%
C6	39-262	5pF, 600V, ±5%
C7	39-155	10pF, 600V, ±5%
C8,9,10	39-382	1uF, 35V
C11, 12	39-063	.001uF, 600V GMV
D1	37-226	Silicon Diode, low leakage
D2,3,4	EYZP-384	Silicon Diode, 60V, 100mA
D5,6	37-196	Zener, 9.1V, 400mW
D7	37-192	Zener, 9V, .002/°C
FWB1	37-182	Full Wave Bridge Rectifier, 60V, 1A
IC1	31-1015	5558 Dual Op. Amp.
IC2	31-1002	709C Op. Amp.
IC3	31-1038	CD-4066 AE Quad Analog Switch
IC4	31-1020	CD-4001 AE Quad NOR Gate
IC5	31-1021	CD-4011 AE Quad NAND Gate
IC6	31-1037	MK-5005P 4-Digit Counter
Q1	31-158	2N5818 Transistor
R1	29-376	500 ohms
R3	CYZR-861-368	49.9k, 1/8W, ±1%
R4	CYZR-861-193	909 ohms, 1/8W, ±1%
R5	29-296	2k, Trimpot, ±10%
R6	40-1986	20k, 1/8W, ±.1%
R7	40-1996	7.371k, 1/8W, ±.1%
R8	40-2008	10k, 1/8W, ±.1%
R9,10	40-2014	40.2k, 1/8W, ±.1%
R11	CYZR-679-4	680 ohms, 1/4W, ±10%
R12,13	CYZR-481-100	10k, 1/4W, ±10%
R14	CYZR-836-318	15k, 1/4W, ±10%
T1	30-352-1	Power Transformer

Digital Span	Jumpers Inserted	R2
0-399 thru 0-999	J1	Jumper
0-9.99 thru 0-99.9	J1	Jumper
200-799 thru 200-999	J2, J3	Omit
0-1200, 0-1399, 0-1999, 200-1199	J1	20k 40-1986
500-1499	J2, J3	20k 40-1986
0-2999	J1	40.2k 40-2014
1300-2299	J2, J3	40.2k 40-2014
0-3999	J1	60.4k 40-1956
2000-3999	J2, J3	60.4k 40-1956
0-200, 0-300, 40-200 *	J1	Jumper
0-2500	J1	40.2k 40-2014
700-1699	J2, J3	20k 40-1986
1300-2299	J2, J3	40.2k 40-2014

*Replace R4 with a jumper

PARTS LIST, 3-DIGIT DISPLAY BOARD A-11080

Item	Part No.	Description
Q1,2,3	31-124	Silicon, NPN, 2N5307
R31	CYZR-836-81	68 ohms, 1/8W, ±10% as needed
LED 1,2,3	36-103	7 Segment LED Display

PARTS LIST, 4 DIGIT DISPLAY BOARD A-11081

Item	Part No.	Description
Q1,2,3,4	31-124	Silicon, NPN 2N5307
R41	CYZR-836-81	68 ohms, 1/8W, ±10% as needed
LED 1,2, 3,4	36-103	7 Segment LED Display

Barber-Colman Company
INDUSTRIAL INSTRUMENTS DIVISION
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DIGITAL INDICATOR SUPPLEMENT

To F-14851 for the Models 521, 522, 523, and 524; and to F-15098 for the Models 525, 526, 527, and 528.

The D-I (Digital Indicator) is on the horizontal board about 4 by 5 inches located at the upper front of the 520 Series Controller. The power transformer for the Digital Indicator is mounted under the D-I board.

OPERATION OF THE DIGITAL PROCESS METER

The digital process meter uses a well-known and proven method of analog to digital conversion known as dual slope integration. A block diagram of a dual slope integrating converter is shown in Figure 1.

TYPICAL CYCLE

Initially the output of the integrator is 0.6 volt negative. The counter is reset, and the integrator input is switched to the process signal input (Vin). The integrator's output begins to rise (Figure 2). As the ramp (integrator output) passes through zero, the zero detector changes state. This allows the control logic to send pulses into the counter. When the counter reaches its maximum count (10,000), it tumbles over to zero. At this point, the control logic switches a fixed reference voltage (Vref) to the integrator input. This opens the circuit from the process signal input and starts pulses to the counter. Vref being opposite in polarity to Vin, causes the integrator output to decrease. As the ramp passes through zero, the zero detector changes state, causing the control logic to strobe the accumulated count into the display latches. This number is proportional to the process signal input, Vin, and is displayed on the digital readout. The counter continues counting to 10,000 and the ramp continues decreasing until 0.6 volts negative is reached. This process is repeated approximately every 2 seconds.

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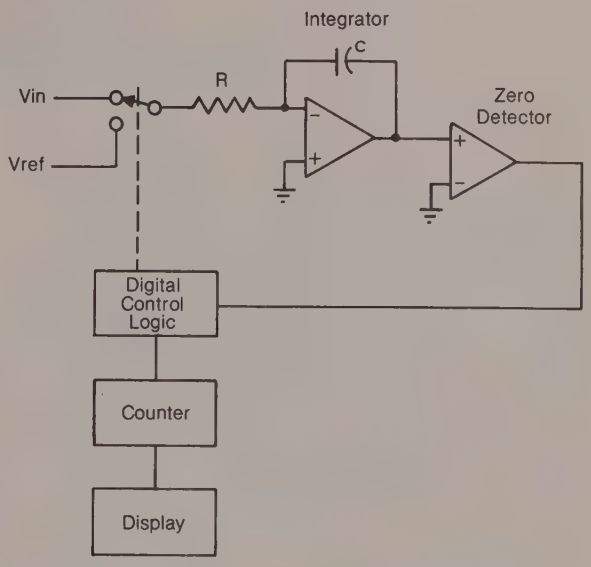


Figure 1.
Block Diagram of Dual Slope A to D Converter

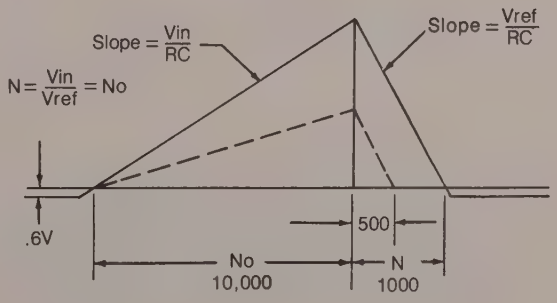


Figure 2. Integrator Output

4.2 Isolation Board Adjustments (All Setpoint Options Except 1 and 4)

This adjustment should be performed only if the Isolation Board A-11121-1 is plugged in and jumpers JA, JB, JC, JD, and JE on the Main Board have been clipped.

1. Place Fluke-meter leads on P6, Pin 7 and Pin 11. Adjust R13 on Isolation Board for +15 volts ±.1%.

2. Place Fluke-meter leads on P6, Pin 4 and Pin 11. Voltage should be −5.1 volts ±5% (4.845V to 5.355V). If it is not in this range diode D8 may be defective.

3. Place a clip-on jumper from P6, Pin 11 to Pin 14. Also, place a Fluke-meter from P6, Pin 1 to P6 Pin 5.

4. Observe the mV reading obtained with the input signal at mid-span. Vary the input signal from the PORTABLE POT, throughout the instrument process range (2V to 10V), and adjust R1 on the Isolation Board for minimum change over the full process span. The Isolation Board should track within .1% of the process span. Example: Process Range = 2V to 10V; Process Span = 8V = 8000 mV (.1% = 8 mV). Note: Tracking may not occur at 0 Vdc offset. Tracking above 40 mV offset may indicate a D1–D2 mismatch, or a bad isolation transformer.

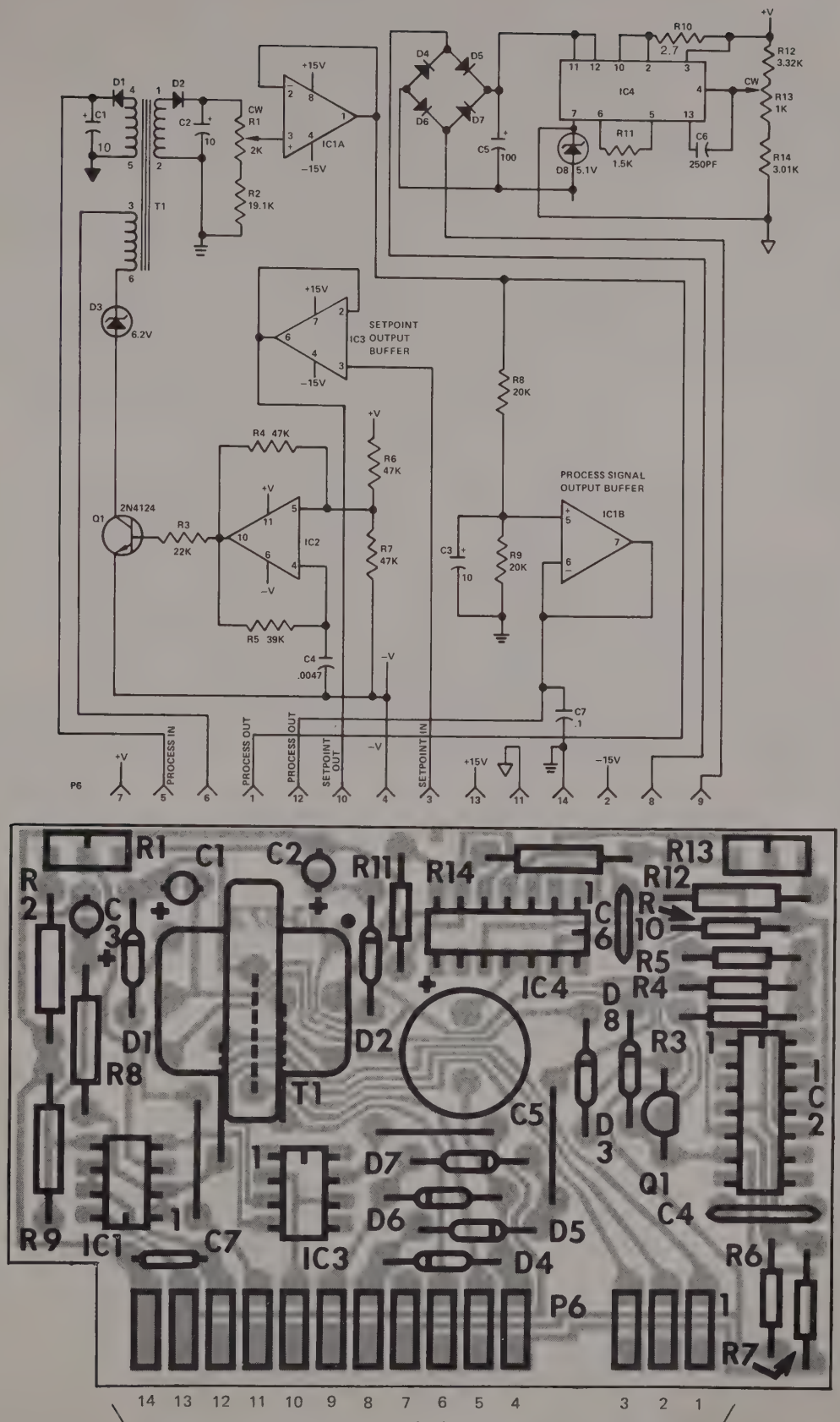
5. Now, with the +15V isolated supply calibrated, and the isolator tracking adjusted with setpoint at medium scale, recalibrate the process output. Disconnect jumper installed in step 3 and adjust R8 on Main Board for 6V ±.1%.

6. Measure the deviation output of IC3A as follows: Connect the positive probe to Pin 1 of P5, and the negative probe to Pin 7 of P5. The precision voltmeter should read 0 Vdc ±.025 Vdc. Adjust R8 for zero deviation.

7. Next, go back to the Main Board Adjustments and do the Meter Span Adjustment.

Table 4-2. Isolation Board A-11121-1, Parts List

Symbol	Part Number	Description
		CAPACITORS
C1,2,3	39-400	10uF, 20%, 15 WVDC, Tantalum
C4	39-466	.0047uF, 10%, 50 WVDC, Polycarbonate
C5	39-163	100uF, +100−10%, 50 WVDC, Electrolytic
C6	39-076	250pF, 20%, 500 WVDC, Ceramic
C7	CYZR-803	.1uF, 20%, 40 WVDC, Monolythic Ceramic
		DIODES
D1,2	A-10057	60 PIV, I_f = 100 mA, Matched Threshold
D3	37-179	6.2V Zener, 5%, 400 mW
D4,5,6,7	EYZP-384	250 PIV, I_f = 100 mA, Silicon Diode
D8	37-162	5.1V Zener, 5%, 400 mW
		INTEGRATED CIRCUITS
IC1	31-1015	Dual 741 Minidip Op Amp
IC2	31-1002	709 Op Amp
IC3	31-1012	741C Op Amp Minidip
IC4	31-1010	723C Voltage Regulator
		TRANSISTOR
Q1	EYZP-632	2N4124 NPN Silicon
		RESISTORS
Resistors are 10%, 1/4W, unless stated otherwise.		
R1	29-377	2k, 20%, 1/2W, Potentiometer
R2	E19-29-328	19.1k, .5%, 1/8W
R3	40-1950	22k
R4,6,7	40-1847	47k
R5	40-1845	29k
R8,9	CYZR-864-330	20k, .5%, 1/8W
R10	E19-35-943	2.7 ohms
R11	CYZR-861-218	1.5k, 1%, 1/8W
R12	CYZR-864-251	3.32k, .5%, 1/8W
R13	29-418	1k, 20%, 1/2W, Potentiometer
R14	CYZR-864-247	3.01k, .5%, 1/8W
		TRANSFORMER
T1	30-319-1	Modulator



Board Connector Numbers — P6 Plugs Into Main Board

Figure 4-1. Isolation Board and Schematic

MODELS 521, 522, 523 and 524

4. ISOLATION BOARD CIRCUITS AND CALIBRATION

4.1 Isolation Board A-11121-1

See Figure 4-1. The Isolation Board isolates the input signal from the process and setpoint output signals.

Preamplifier IC1 on the Main Board, when used as an isolated version, requires an isolated power supply. This is provided by the additional winding on the Main Board power transformer T1 (violet, violet-white) and regulated supply IC4 located on the Isolation Board. The process signal (P6, Pin 6) is chopped via oscillator IC2 and switching transistor Q1. The square wave level in output winding, 1–2 varies in proportion to the chopped input to winding, 3–6. Feedback winding, 4–5 reduces distortion and improves linearity. The isolated process signal appears at P6, Pin 1 via follower IC1A and the rectified-filtered DC input from T1 winding, 1–2. Buffering is provided by followers IC3 (setpoint output) and IC1B for process signal output. Process and setpoint output is 1 to 5 volts.

Table 4-1. Summary of Adjustments on Isolation Board

Symbol	Description
R13	+ 15V Voltage
R1	Tracking

Barber-Colman Company
INDUSTRIAL INSTRUMENTS DIVISION
1300 Rock Street, Rockford, Illinois, U.S.A., 61101

January, 1977

LITHO IN U.S.A.

Series 520
Troubleshooting Main Board and Range Boards, Changing Ranges

5. TROUBLESHOOTING

5.1 General

All of the Controller, except the preamplifier stage of IC1, can be troubleshot with a VOM of 20,000 ohms/volt sensitivity. Do not attempt to make major repairs on the Main Board. Minor repairs such as replacing broken pins may be made. Recalibrate the Main Board if you replace any critical component on it.

When making repairs on printed circuit boards or soldering transistor or integrated circuit terminals, use a 35 watt or less soldering iron and 63/37 or 60/40 resin core solder.

Following is a list of instruments for field troubleshooting the Controller.

Oscilloscope with calibrated sweep or equivalent (required to check waveforms).

Accurate DC Voltmeter

Strip Chart Recorder

In any general troubleshooting procedure, always do paragraph 5.2 first.

5.2 Power Supply Board

Measure all voltage outputs. If any part is replaced the controller must be completely recalibrated.

5.3 Excessive Drift of Either Setpoint or Process Temperature

The drift may be due to thermocouple deterioration. Thermocouple deterioration is usually found in a periodic inspection program. To determine thermocouple deterioration place the test thermocouple as close to the thermocouple under test as possible. If the output of the thermocouple under test differs from what is acceptable by the user (outside his or the manufacturer's specifications) then the thermocouple is defective.

Inspect thermocouple to leadwire and leadwire to controller connections to be certain they are covered properly so that air drafts across them are not affecting temperature indications by causing temperature gradients.

Measure the line voltage. It must be within the specified range.

5.4 Preamplifier IC1 and Range Board

Troubleshooting the Preamplifier stage of IC1 and the Range Board to which it is connected, requires battery operated voltmeters with input impedances of 10M ohms or higher.

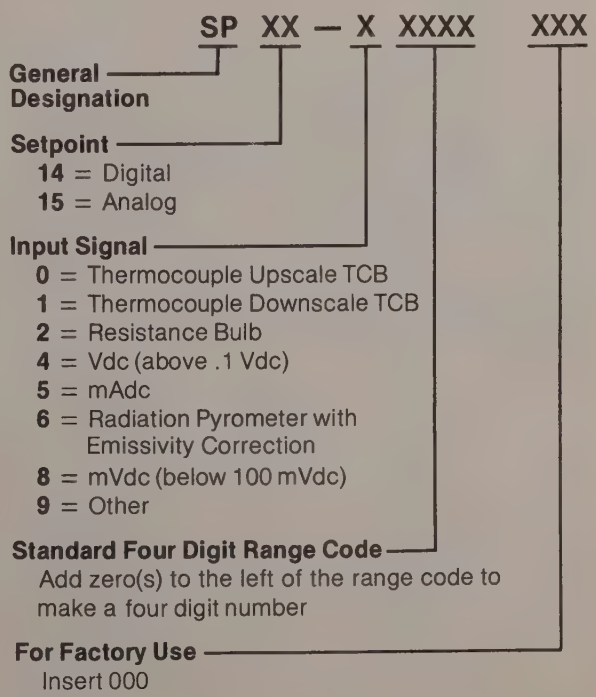
Battery operated test instruments with such an input impedance are the Hewlett-Packard Company Model 427A Multi-Function Meter and the John Fluke Manufacturing Company Model 871AB DC Differential Voltmeter. The remainder of the controller following the DC Amplifier may be troubleshot with a VOM with a 20,000 ohms/volt voltmeter or higher sensitivity.

5.5 Thermocouple Break Check

1. Disconnect any input (TC or dc millivolt source).
2. The Temperature Indicator should go full scale.
3. A milliammeter connected across the current output terminals should indicate zero.

5.6 Range Board Assemblies

Individual components on this assembly should not be replaced. When ordering a complete range board assembly, the following code must be written.


SP XX — X XXXX XXX
General Designation
Setpoint
14 = Digital
15 = Analog
Input Signal
0 = Thermocouple Upscale TCB
1 = Thermocouple Downscale TCB
2 = Resistance Bulb
4 = Vdc (above .1 Vdc)
5 = mAdc
6 = Radiation Pyrometer with Emissivity Correction
8 = mVdc (below 100 mVdc)
9 = Other
Standard Four Digit Range Code
Add zero(s) to the left of the range code to make a four digit number
For Factory Use
Insert 000

STANDARD RANGES FOR DIGITAL SETPOINTS AND FOR ANALOG SETPOINTS WITH SINGLE RANGE TEMPERATURE DIAL DIVISIONS

Thermocouple Ranges

Range	Code Number for Range and Thermocouple Type					
	J	K	R	S	B	Tungsten 5% Rhenium–Tungsten 26% Rhenium*
0–399°F	56					
0–499°F	306					
0–599°F	15					
0–799°F	16					
0–999°F	17	207				
0–1999°F		30	166	316		
0–2999°F			38	36	1814	
2000–3999°F						3382
200–799°F	751					
200–1199°F	203	2411				
500–1499°F	2980	3406				
1300–2299°F		3531				
0–399°C	22					
0–499°C	23					
0–599°C	24	110				
0–799°C		32				
0–999°C		33	276			
0–1999°C					3611	2552
200–1199°C		185	1597	3713		
500–1499°C			521	1395		3719

*No Symbol. Positive Wire is Hoskins Alloy 405. Negative Wire is Hoskins Alloy 426.

J—Iron Constantan K—Chromel Alumel R—Plat 13%
S—Plat 10% B—Plat 30% Rh/Plat 6% Rh

STANDARD RANGES FOR ANALOG SETPOINTS (°F AND °C) WITH DUAL RANGE TEMPERATURE DIAL DIVISIONS

The temperature range listed in column 1 is marked on the inner scale of the dial.

Thermocouple Ranges

Range	Code Number J
0–800°F	231
200–800°F	3644

RESISTANCE TEMPERATURE DETECTOR (RTD) RANGES

(100 ohm Resistance Bulb)

Range	Code
0 to 100°F	3550
0 to 100°C	4039
0 to 200°C	4119
0 to 400°F	1815
0 to 400°C	4022
0 to 600°F	4173
0 to 800°F	2345
200 to 800°F	4174

Range	Standard Millivolt Ranges–Uncompensated
0–9.99mV	381
0–49.9mV	1054
0–99.9mV	2892
–5 to 0 to + 5mV	1324*

*Available only with Analog Setpoint

STANDARD RANGES FOR ANALOG SETPOINTS WITH SINGLE RANGE TEMPERATURE DIAL DIVISIONS

Cryogenic (Low Temperature) Ranges

Range	J	T	100 RTD PT*
–400°F to 0°F	—	—	4164
–300°F to + 300°F	318	545	—
–100°F to + 100°F	—	—	4169

* The RTD range cards are calibrated for the ranges specified and apply to a 100 ohm (at 0°C) platinum element with a temperature coefficient of .00385 ohm/ohm/°C. Consult factory for other ranges and for sensors with other temperature coefficients.

5.7 Changing Ranges

5.7.1 IDENTICAL RANGES

Changing range boards with identical ranges is very easy. Unplug the old range board and plug in the new range board. The new range board is factory calibrated and no calibration is required.

5.7.2 CHANGING FROM ONE SPAN TO ANOTHER WITHIN THE SAME KIND OF RANGE

For example, suppose a 0–399°F range board is replaced by a 0–599°F range board.The digital setpoint will still be effective but only up to 399°F. The setpoint must be modified. Also, the 6 Vdc Process Signal Adjustment and the 3 Vdc Setpoint Voltage Adjustment on the Main Board must be adjusted. Don't forget that any process meter should be replaced.

5.7.3 CHANGING BOTH SPANS AND KINDS OF RANGES

For example, suppose a 0–399°F range board is replaced by a 0–49.9 mV range board. The digital set-

point must be modified. The 6 Vdc Process Signal Adjustment and the 3 Vdc Setpoint Voltage Adjustment on the Main Board must be adjusted. Any process meter scale must be replaced.

5.8 Setpoint Switch Assemblies

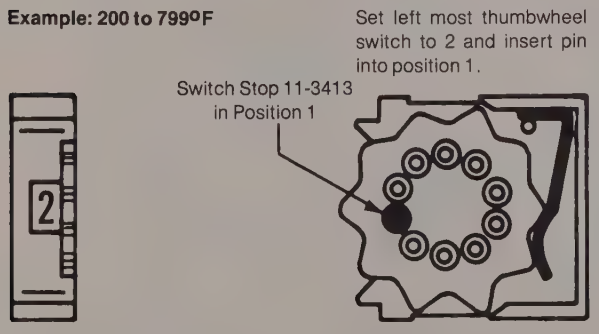
Digits	Part Number	Digital Span
3	A-10342-100	0–X99
3	A-10342-200	200–X99
3	A-10342-300	500–X99
3	A-10342-400	1300–XX99
4	A-10343	0–9999

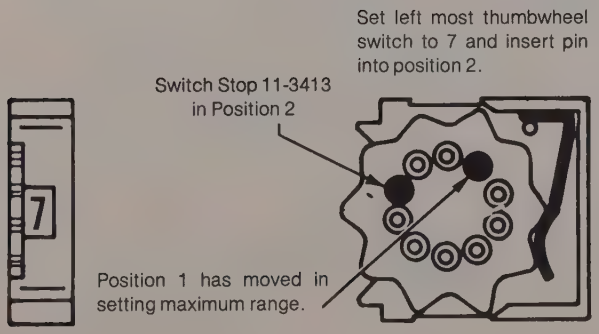
5.9 Modifying a 3-Digit Setpoint Assembly to Change its Range

To install the setpoint assembly, proceed as follows:

1. Hold modules and mounting cover together. Place one of the straps up from the bottom. Place second strap down with the short ends meeting the long ends. Short end should overlap on both sides and snap in place.
2. To set left most thumbwheel switch of the setpoint assembly (hundreds position) to minimum value of the required range, insert switch stop pin (part number 11-3413) into position 1. See example.
3. To set left most thumbwheel switch of the setpoint assembly (hundreds position) to the maximum value of the required range minus one, insert switch stop pin (part number 11-3413) into position 2. See example. Pins are not required for the ranges from 0 to 999.

Example: 200 to 799°F



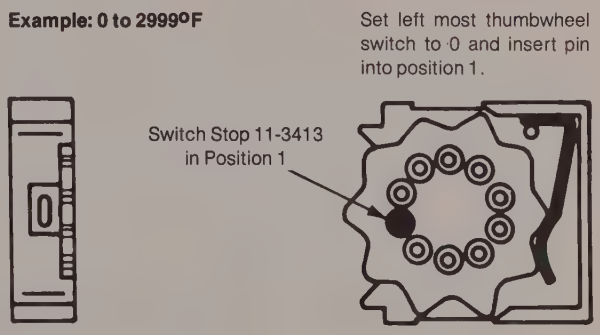

Set left most thumbwheel switch to 7 and insert pin into position 2.
Switch Stop 11-3413 in Position 2
Position 1 has moved in setting maximum range.
7

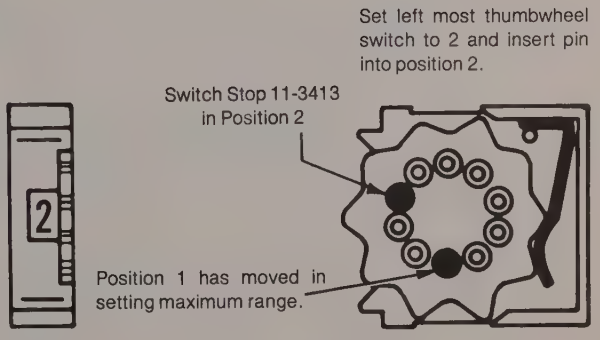
5.10 Modifying a 4-Digit Setpoint Assembly to Change its Range

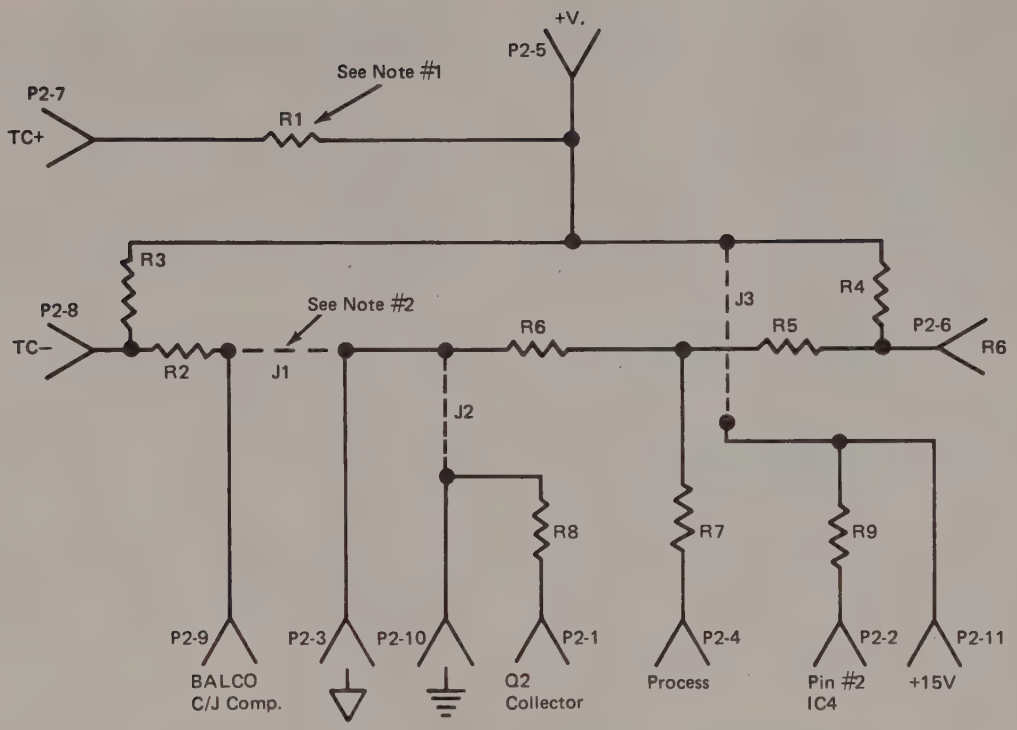
To install the setpoint assembly, proceed as follows:

1. Hold modules and mounting together. Place one of the straps up from the bottom. Place second strap down with the short ends meeting the long ends. Short end should overlap on both sides and snap in place.
2. To set left most thumbwheel switch of the setpoint assembly (thousands position) to the minimum value of the required range, insert switch stop pin (part number 11-3413) into position 1. See example.
3. To set left most thumbwheel switch of the setpoint assembly (thousands position) to the maximum value of the required range minus one, insert switch stop pin (part number 11-3413) into position 2. See example.

Example: 0 to 2999°F



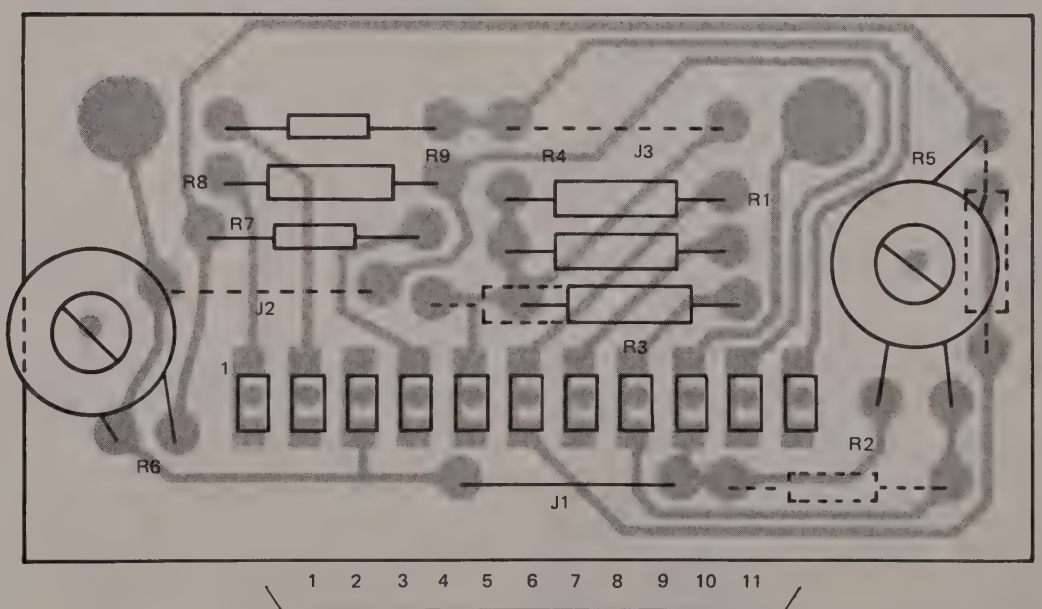

Set left most thumbwheel switch to 2 and insert pin into position 2.
Switch Stop 11-3413 in Position 2
Position 1 has moved in setting maximum range.
2



Notes

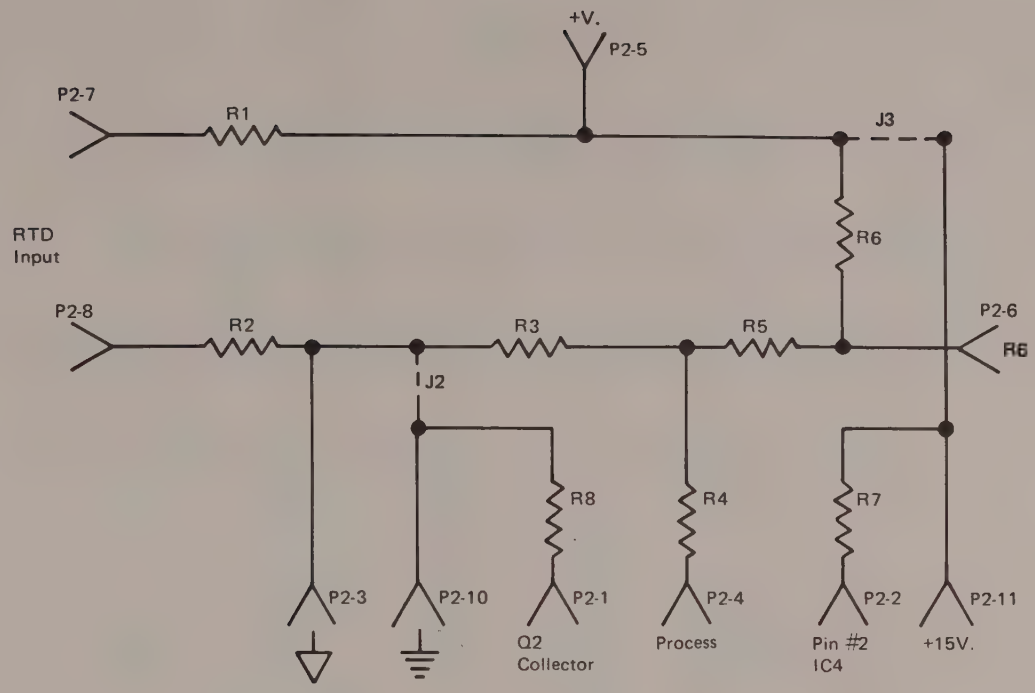
1. R1 is omitted for downscale TCB.
2. J1 is inserted for mV and Type B T/C ranges only.
3. J2 and J3 on SP05 and SP06.
4. R8 and R9 on Digital Setpoints.

R1 is the standard thermocouple break protection resistor. Resistors R2 and R5 set the required millivolt suppression to achieve the 2 to 10 Vdc process signal. R3 determines the current for the cold junction compensation by R2 on the Main Board. R6 and R7 are the preamplifier gain resistors. Resistors R8 and R9 are for span and suppression of the setpoint, respectively.



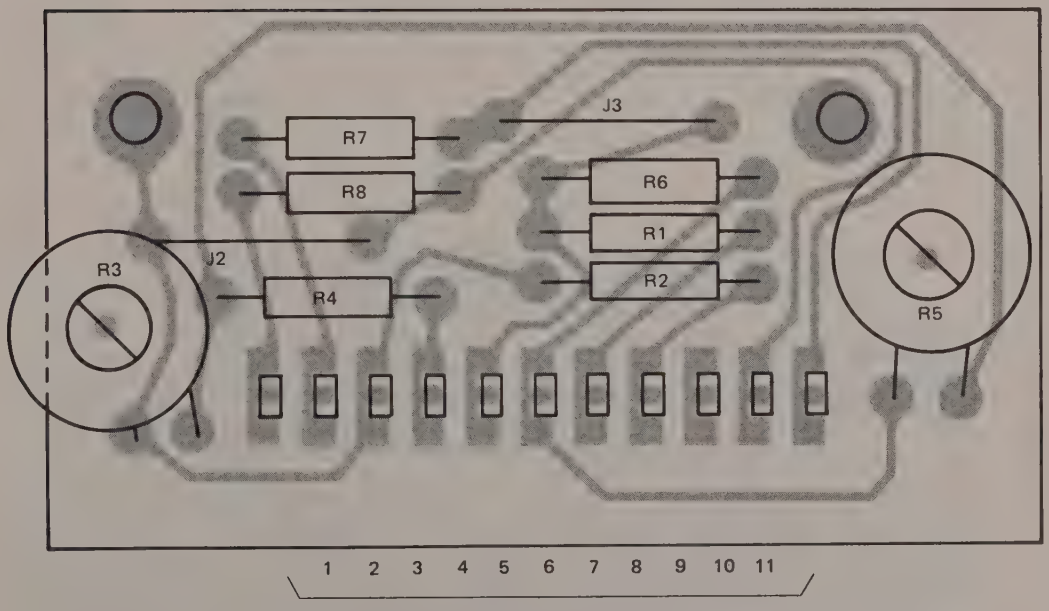
Board Connector Numbers—P2 Plugs Into Main Board

Figure 5-1. Thermocouple and Millivolt Range Board and Schematic



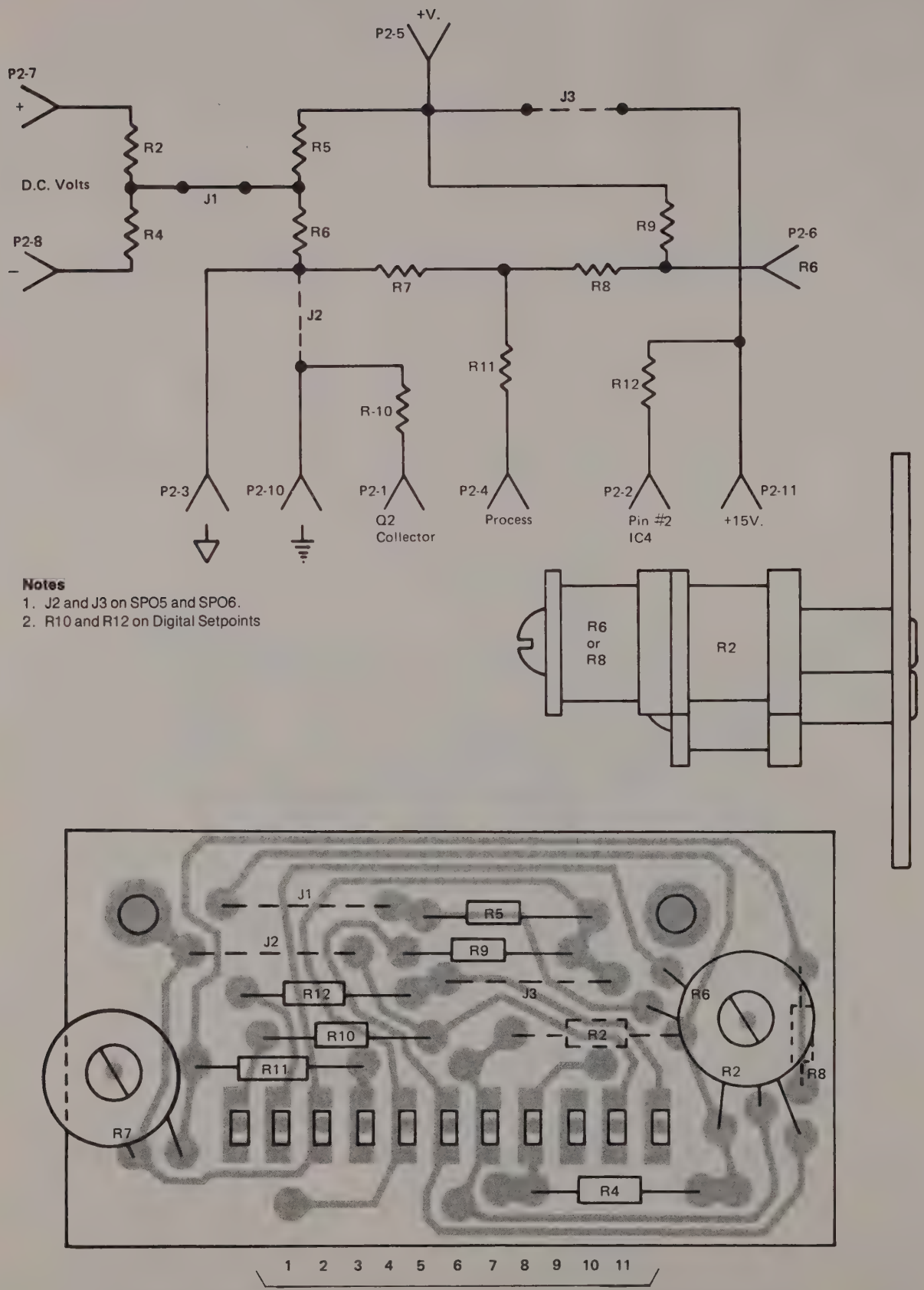
Notes

1. J2 and J3 on SPO5 and SPO6.
2. R8 and R7 on Digital Setpoints



Board Connector Numbers—P2 Plugs Into Main Board

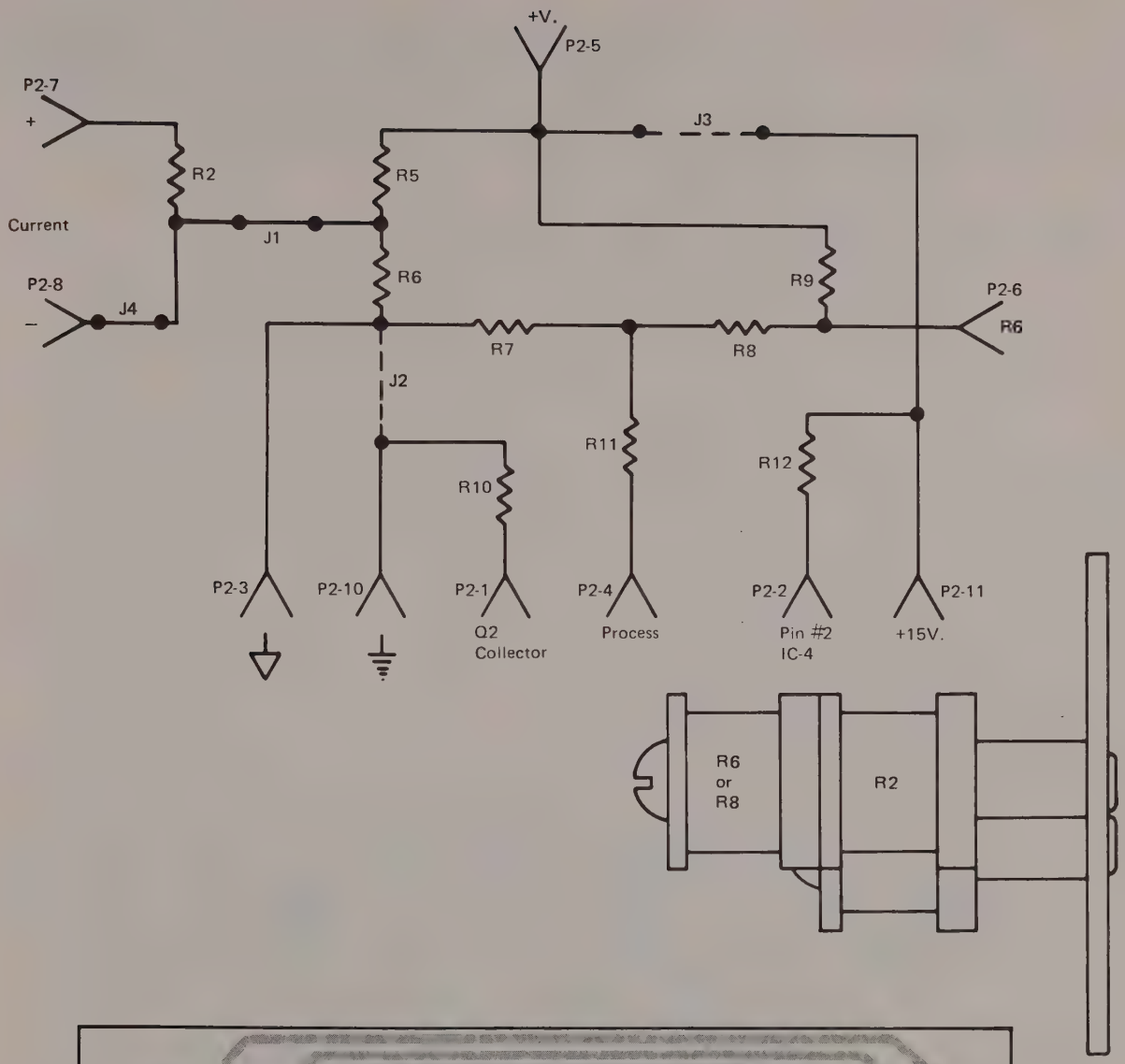
Figure 5-2. Resistance Temperature Detector (RTD) Range Board and Schematic

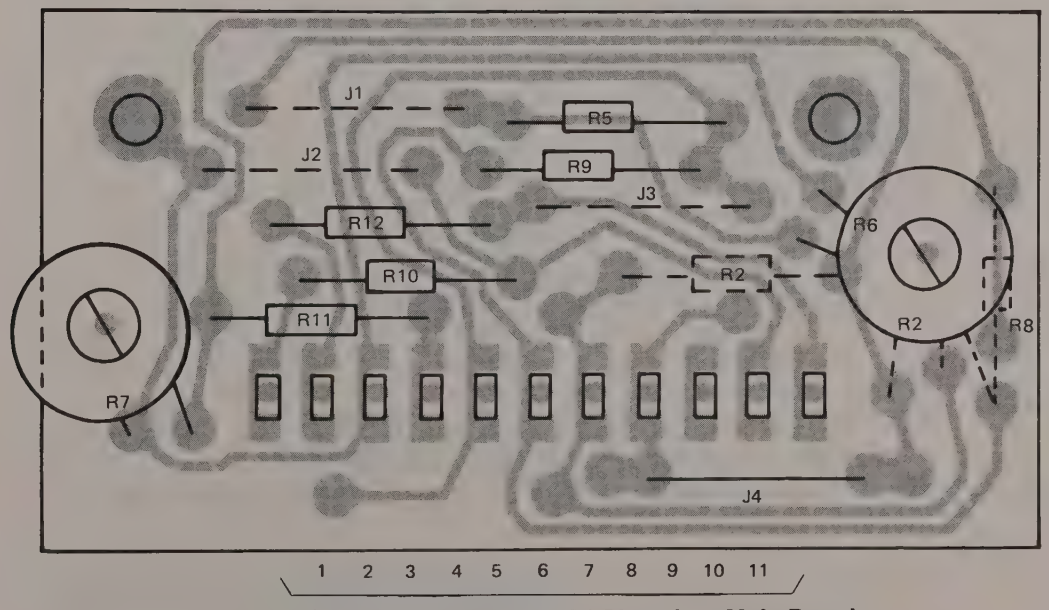


Notes
1. J2 and J3 on SPO5 and SPO6.
2. R10 and R12 on Digital Setpoints

Figure 5-3. Voltage (both above and below .1 Vdc) Range Board and Schematic

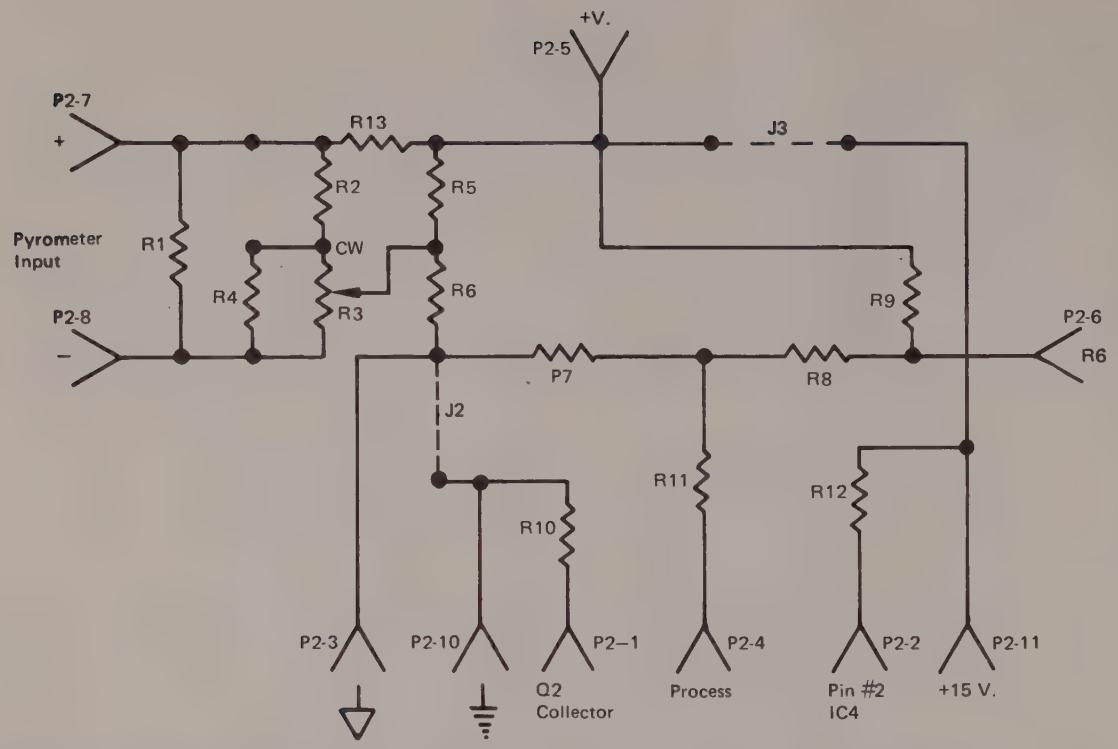
Board Connector Numbers—P2 Plugs Into Main Board



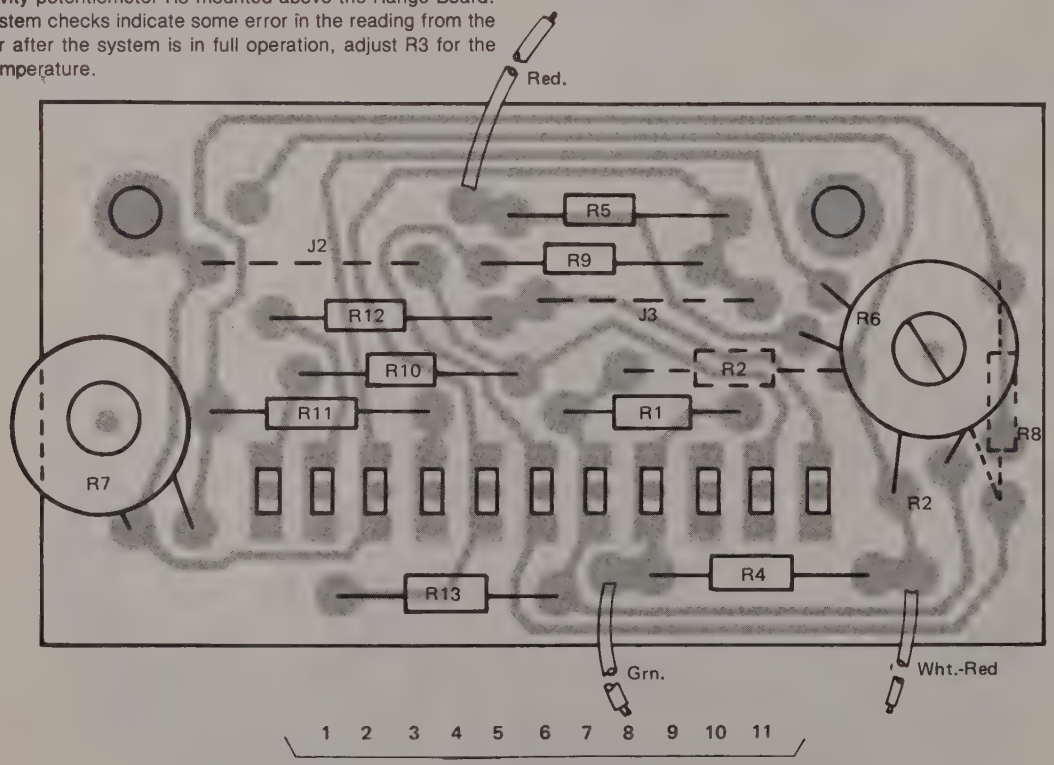


Board Connector Numbers—P2 Plugs Into Main Board

Figure 5-4. Current (mAdc) Range Board and Schematic



To Emissivity potentiometer R3 mounted above the Range Board. Should system checks indicate some error in the reading from the Pyrometer after the system is in full operation, adjust R3 for the correct temperature.



Board Connector Numbers—P2 Plugs Into Main Board

Figure 5-5. Radiation Pyrometer with Emissivity Correction Range Board and Schematic

Barber-Colman Company
INDUSTRIAL INSTRUMENTS DIVISION
1300 Rock Street, Rockford, Illinois, U.S.A., 61101

SERIES 520
CIRCUIT DESCRIPTION AND SERVICE ALARM BOARD

6. Alarms

6.1 GENERAL

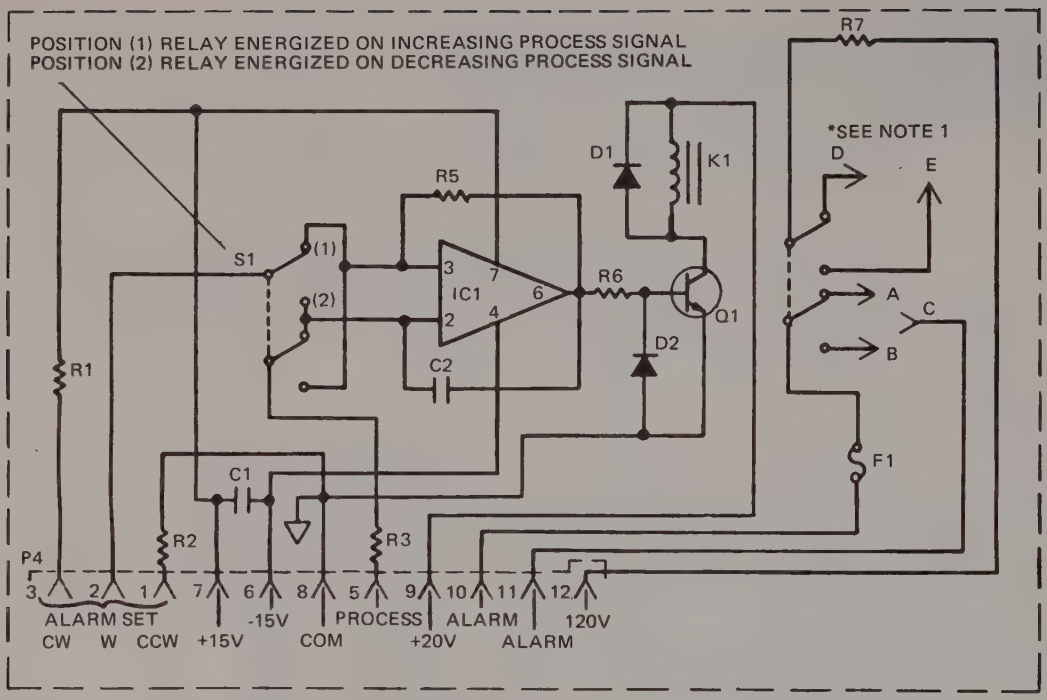
Connections and adjustments for the Alarm Circuit are given in the Installation and Wiring Section for this manual. The alarm circuit is a simple voltage sensing circuit that drives a relay with an alarm contact rating of 2A at 120 Vac. The ALARM SET resistor R1 on the Main Board generates the reference voltage to which the process or deviation signal is compared at the input pins of IC1 on the alarm board. The ALARM SET resistor R1 is located at the upper left corner of the schematic of Figure 3-2.

6.2 PROCESS AND DEVIATION ALARMS

The operation of both alarms is the same except for the input. The Process Signal input is on pin 5 on Figure 6-1. The Deviation Signal input is on pin 4 on Figure 6-2. If either the Deviation or Process Signal causes IC1 to turn on, the positive going output of IC1 turns on Q1, energizing K1. When K1 is energized, the front panel red alarm lamp goes off and remains off until IC1 turns off, deenergizing K1.

6.3 DEVIATION BAND ALARM

The Deviation Signal input is on pin 4 on Figure 6-3. IC1B and D1 form an "absolute value" circuit. The polarity of the "error" signal on the cathode of D1 always goes from 0 Vdc to a positive voltage with either a positive or a negative Deviation Signal on pin 4. The incoming Deviation Signal can swing to +4 Vdc or to -4 Vdc, depending on whether the process is above or below setpoint. The amplitude of the voltage on the cathode of D1 must always equal the amplitude of the voltage of the Deviation Signal. For example, if the Deviation Signal is either -4 Vdc or +4 Vdc, the voltage from the cathode of D1 to pin 8 (common) is +4 Vdc in both cases. The "error" voltage on the cathode of D1 is compared with the alarm trip point voltage set by the ALARM SET resistor R1 on the Main Board. If the "error" signal causes IC1 to turn on, the positive going output of IC1 turns on Q1, energizing K1. When K1 is energized, the front panel red lamp goes off and remains off until IC1 turns off.



***Note 1:** One lead of Alarm Pilot Light connects to either point D or E. The other lead connects to pin I on the Main Board.

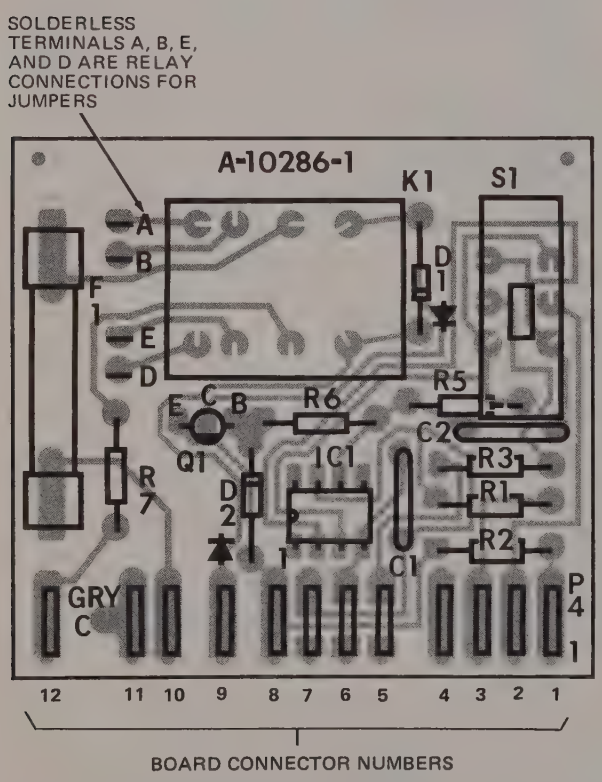
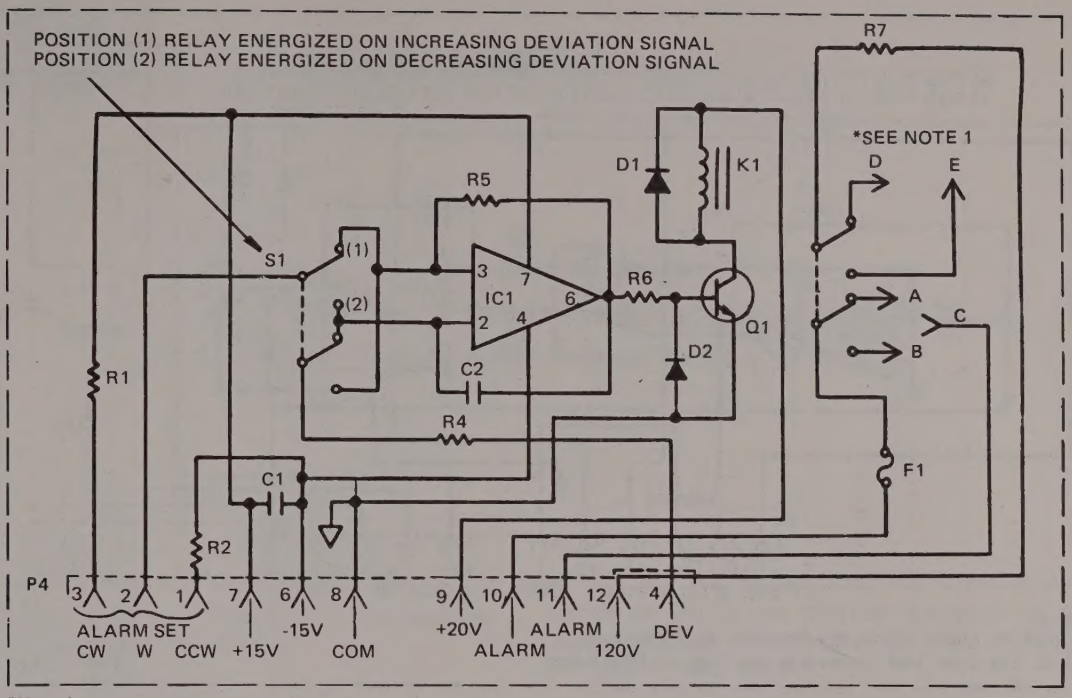


Figure 6-1. Process Alarm Board A-10286-1 and Schematic

Symbol	Part Number	Description
CAPACITORS		
C1,2	39-325	.05 uF 20% 100 WVDC
DIODES		
D1,2	EYZP-384	250PIV, I_f = 100 mA
FUSE		
F1	SYZE-206	2A, type AGC2
INTEGRATED CIRCUIT		
IC1	31-1012	741C Operational Amplifier
RELAY		
K1	38-205	DPDT, 20 Vdc, 12 mA
TRANSISTOR		
Q1	31-082	2N3416
RESISTORS Resistors are 10% tolerance, 1/4W, unless stated otherwise		
R1	CYZR-861-348	30.9k ohms 1%, 1/8W
R2	CYZR-861-310	12.4k ohms 1%, 1/8W
R3	40-1950	22k ohms
R5	40-1871	10M ohms
R6	40-1950	22k ohms
R7	40-1706	120k ohms 5%
SLIDE SWITCH		
S1	32-388	DPDT

Table 6-1. Process Alarm Board A-10286-1 Parts List



***Note 1:**
One lead of Alarm Pilot Light connects to either point D or E. The other lead connects to pin I on the Main Board.

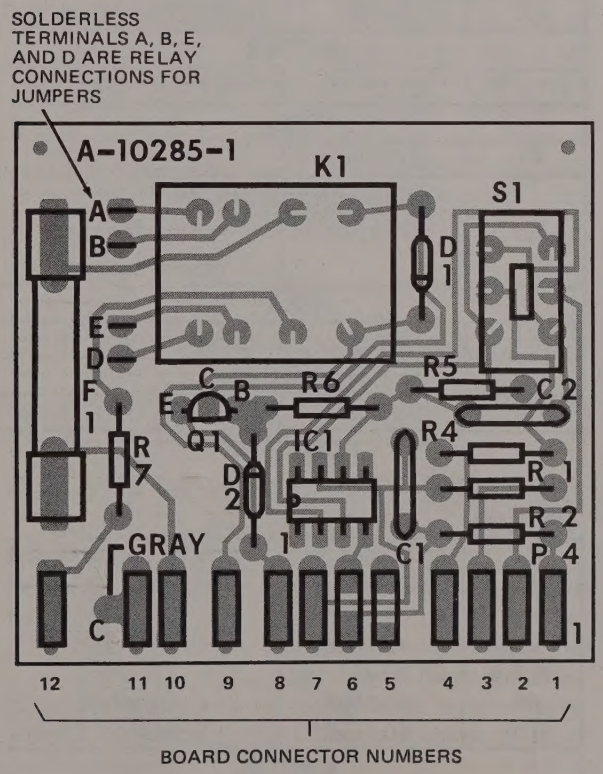
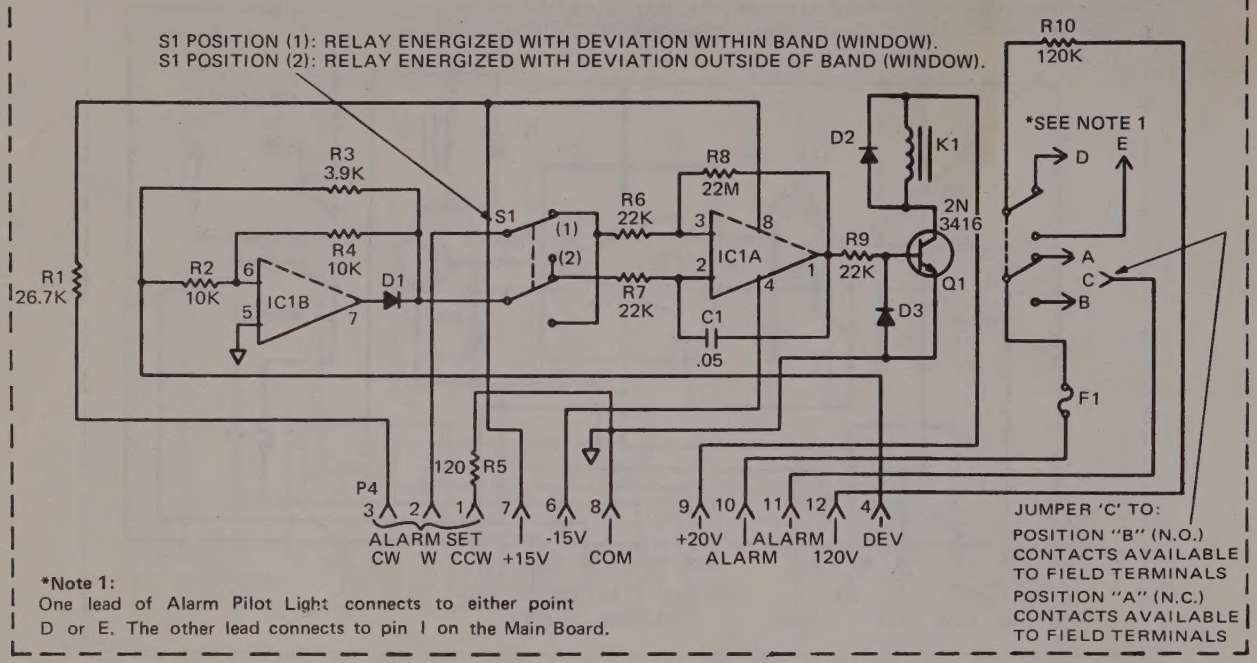


Figure 6-2. Deviation Alarm Board A-10285-1 and Schematic

Symbol	Part Number	Description
CAPACITORS		
C1,2	39-325	.05 uF 20% 100 WVDC
DIODES		
D1,2	EYZP-384	250 PIV, If = 100 mA
FUSE		
F1	SYZE-206	2A, type AGC2
INTEGRATED CIRCUIT		
IC1	31-1012	741C Operational Amplifier
RELAY		
K1	38-205	DPDT, 20 Vdc, 12 mA
TRANSISTOR		
Q1	31-082	2N3416
RESISTORS Resistors are 10% tolerance, 1/4W, unless stated otherwise		
R1	CYZR-861-307	11.5k ohms 1%, 1/8W
R2	CYZR-861-305	11.0k ohms 1%, 1/8W
R4	40-1552	8.2k ohms
R5	40-1808	2.7M ohms
R6	CYZR-481-160	22k ohms
R7	40-1706	120k ohms 5%
SLIDE SWITCH		
S1	32-388	DPDT

Table 6-2. Deviation Alarm Board A-10285-1 Parts List



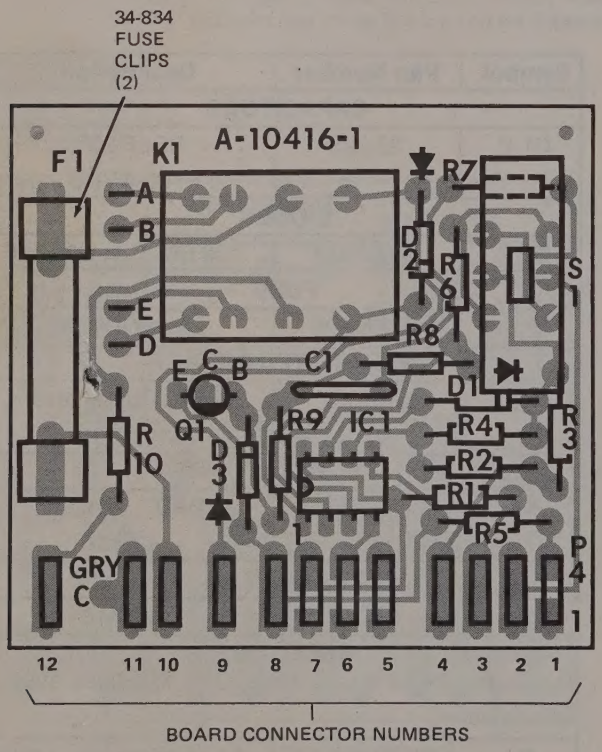


Figure 6-3. Deviation Band Alarm Board A-10416-1 and Schematic

Symbol	Part Number	Description
CAPACITOR		
C1	39-24	.05 uF 20%, 100 WVDC
DIODES		
D1,2,3	EYZP-384	250 PIV, If = 100 mA
FUSE		
F1	SYZE-206	2A, type AGC2
INTEGRATED CIRCUIT		
IC1	31-1015	Dual Minidip Operational Amp.
RELAY		
K1	38-205	DPDT, 20 Vdc, 12 mA
TRANSISTOR		
Q1	31-082	2N3416
RESISTORS		
Resistors are 10% tolerance, 1/4W, unless stated otherwise		
R1	CYZR-861-342	26.7k ohms 1%, 1/8W
R2,4	CYZR-861-301	10k ohms 1%, 1/8W
R3	40-1557	3.9k ohms
R5	40-1758	120 ohms
R6,7,9	CYZR-481-160	22k ohms
R8	40-1857	22M ohms
R10	40-1706	120k ohms 5%
SWITCH		
S1	32-388	DPDT, Slide Switch

Table 6-3. Deviation Band Alarm Board A-10416-1 Parts List

Barber-Colman Company
INDUSTRIAL INSTRUMENTS DIVISION
1300 Rock Street, Rockford, Illinois, U.S.A., 61101

MODELS 521L and 521T

8. OUTPUT BOARD CIRCUIT DESCRIPTION and SERVICE

This is the last section of Service Manual 1252 IN24.

8.1 GENERAL

The circuit description, calibration, and troubleshooting follows in paragraphs 8.2, 8.3, and 8.4.

8.2 CIRCUIT DESCRIPTION

Only the components shown on the schematic of Figure 8-1 are on the Board. When the Deviation Signal on pin 1 of P5 goes more negative (meter goes positive) than the voltage level on pin 7 of P5, the output of IC1 on pin 6 approaches the potential of the -15 Vdc supply. When the Deviation Signal on Pin 1 goes more positive (meter goes negative) than the voltage level on pin 7 of P5, and the front panel RESET pushbutton S1 is pressed, IC1 approaches 15 Vdc and turns Q1 on, allowing K2 to be energized.

The rating of K2 is 10A at 120 Vac; 5A at 240 Vac.

Fuse F1 on the Main Board is in series with relay K2. The fuse is rated 20A at 250 Vac. Fuse size must not be exceeded. The copper foil on the Main Board will be destroyed at higher currents.

The extra circuit for the Model 521T is located at the upper left hand of the schematic of Figure 8-1.

The extra circuit for the Model 521T provides automatic resetting on initial start up and on line voltage interruptions. When power is turned on, C7 momentarily appears to be a short circuit. The supply voltage is developed across R8, turning on Q3. R9 in the voltage divider is momentarily shorted by this action. When C7 starts to charge, Q3 starts to turn off. The voltage across R9 begins to increase, turning on Q4. C8 also tends to slow down the rate of voltage developed on the base of Q4. When Q4 turns on, it energizes the reed relay K1.

The reed relay contacts of K1 appear to be a secondary reset switch. The switch is momentarily held open, to cause the reset condition on initial power or line voltage interruptions.

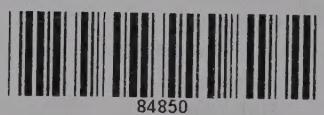
8.3 CALIBRATION

There are no board adjustments.

8.5 TROUBLESHOOTING

Replacement of a suspected defective board will localize trouble quickly. Connecting a dc millivolt source to rear panel input terminals 1 and 2 and varying the source over the range for different settings of the SETPOINT ADJUST control will localize trouble to the Limitrol but not to the output board.

Check the operation of IC1 by varying the deviation signal. When the deviation signal on pin 1 of P5 is more negative than the voltage on pin 7 of P5, the output of IC1 on pin 6 should approach -15 Vdc. At this time relay K2 should be deenergized. When the deviation signal on pin 1 goes more positive than the voltage on pin 7 of P5, and the front panel Reset pushbutton S1 is depressed, the output of IC1 on pin 6 should approach +15 Vdc, and relay K2 should be energized. If relay does not energize, check the voltage across R7 which should be 30 Vdc. If 30 Vdc is present, and the output voltage of IC1 approaches 15 Vdc, Q1 probably has failed.



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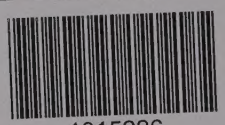

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